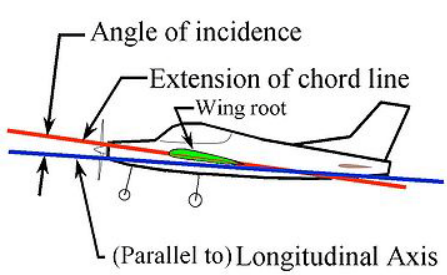
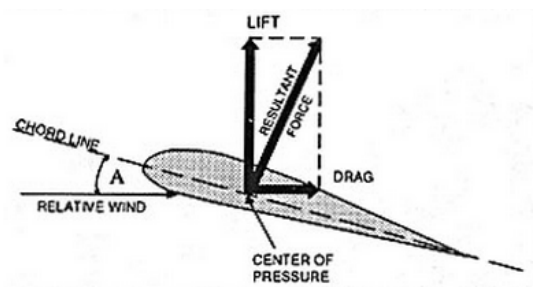
PPL Notes

Contents

The Airplane

Forces on an aircraft





- Lift, drag, weight, and thrust
- In an unaccelerated flight (straight and level at a constant speed) the 4 forces are in equilibrium
- In a venturi the pressure is lowest at the narrowest point where air movement is the fastest
- Chord line – line from leading to trailing edge of wing
- Relative wind – air movement parallel to the course of the aircraft
- Angle of attack – the angle between chord line and relative wind
- Angle of incidence – the angle between the chord line and the longitudinal axis of the airplane

Stalls and spins

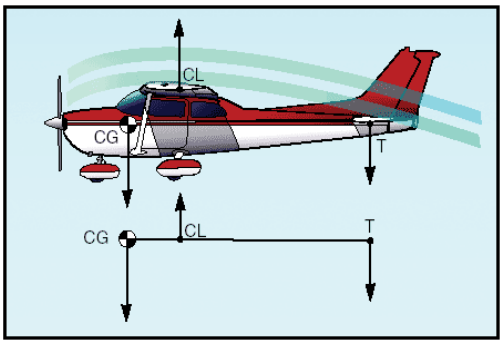
- A particular airplane **stalls**:
  - At the same <u>angle of attack</u> regardless of its <u>weight</u>
  - At the same <u>indicated airspeed</u> regardless of the <u>altitude</u>
- In a spin both wings are stalled, one more than the other
- Frost may cause an airplane to stall (it increases the stall airspeed)

- Stalls can happen during landing if the pilot thinks he is too low and pitches up. Add power instead

Left turning tendency

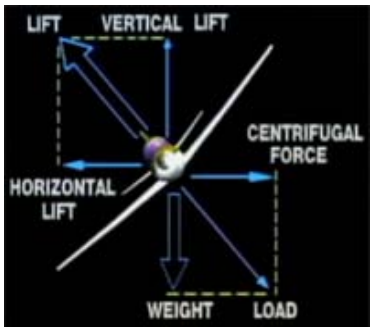
- The propeller turns clockwise when viewed from the cockpit
- P-Factor (asymmetric propeller loading) is caused by the right (descending) propeller blade producing more thrust than the left (ascending) one, and causes left yaw on high angles of attack
- P-Factor becomes higher at:
    - High torque (power)
    - Low airspeed
    - High angle of attack
    - Typically during climb, slow flight, and stalls
- Use right-rudder to counteract
- In high airspeed, built-in counterbalance fixes that
    - Smaller angle of incidence on right wing, right-leaning tail

Stability



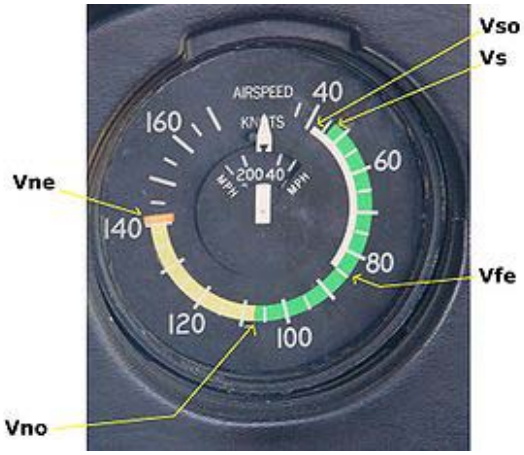
- Inherently stable airplane takes less effort to control
- Longitudinal stability: the airplane is designed to fly horizontally
- Loading the airplane to the most aft CG limit will make it less stable at <u>all speeds</u>
- Loading the airplane further **back** of the most aft CG limit will make it <u>harder to control in a stall</u>
- Nose down pitch tendency occurs when power is reduced because the downwash slipstream from the propeller is lower, making the elevator less effective in pushing the tail down (except for in T-wing airplanes where the tail is high)
- Changing the center of pressure (=center of lift, CL) will affect the aerodynamic balance, controllability and stability of the airplane
    - Most commonly caused by changing the angle of attack

Turns



- The **horizontal component of lift** makes the airplane turn
- Load factor (expressed in G) is increased during turns
- During an approach to a stall, increased load factor will cause the airplane to stall at a higher speed
- Total Lift = Load factor * Weight
- The amount of excess load that can be imposed on the wing depends on the speed of the airplane. At low speed, high excess load will cause the airplane will stall
- Flaps increase drag without increasing airspeed

V speeds



- V_X – Best angle of climb, best angle over an obstacle
- V_Y – Best rate of climb, best altitude over time
- V_A – maneuvering speed *(not shown on airspeed indicator)*
    - In severe turbulence, reduce speed to V_A, maintain level flight, and allow minor variations in airspeed and altitude
- White arc: flaps operating range
    - V_{SO} – stall speed with flaps and landing gear extended (landing configuration) - *bottom of white arc*
    - V_{FE} – maximum speed with flaps extended - *top of white arc*

- Green arc: normal operating range
    - V_S – power off stalling speed – *bottom of green arc*
    - V_{NO} – maximum structural cruising speed – *top of green arc*
- Yellow arc: caution range
    - V_{NE} – Never Exceed speed – red radial line. Maximum operating speed in smooth air
- V_{LE} – Maximum Landing gear Extended speed

Wake turbulence (wingtip vortices)

- Wake turbulence is created when an airplane is creating lift
- Turbulence circulates outward, upward, and around each wingtip
- Stronger when the airplane is in a higher angle of attack – when it's heavy, slow, and clean (landing gear and flaps retracted)
- Vortices sink down at 400-500' per minute and spread apart
- Stay above the other airplane and land after its touchdown point
- When departing, fly above and upwind from the airplane generating vortices
- **Light quartering tailwind** can move one of the vortices to the center of the runway

Ground effect

- Airplanes fly better within about one wingspan from the ground
- Caused by the ground interfering with the air's ability to go around the wingtip and destroy lift
- May result in becoming airborne before reaching recommended takeoff speed
- Ground effect increases lift and decreases drag
    - Any excess speed at the point of flare can cause floating

Dual ignition system (magnetos)

- For Improved engine performance and redundancy
- The two spark plugs ignite fuel/air mixture from both sides to guarantee a centered explosion

Electric fuel pump

- The electric fuel pump is designed to be an auxiliary to the engine driven fuel pump, not to be used all the time

Electrical system failure

- Will not stop the engine
- The following will stop working:
    - Avionics
    - Lights
    - Flaps (if electrical)

Engine start

- Right after starting, adjust RPM
- Then, check gauges – especially oil pressure

Propeller

- Fixed pitch is not optimized for all speeds
- Constant speed propeller lets the pilot select the blade angle for the most efficient performance
    - The throttle sets the manifold pressure
    - The pilot sets the desired RPM with the propeller control, and the governor automatically adjusts the blade angle to maintain that RPM
- High manifold pressure and low RPM can damage the engine

Mixture

- Fuel/air mixture is adjusted to decrease fuel flow in high altitudes so the proper ratio is maintained

- If the engine is rough when the carburetor heater is on, the mixture is probably too rich (becoming richer with carb heat); change to a leaner setting
- On descent from high altitude, mixture should be changed to a richer setting

Float type carburetor

- Depends on a difference in air pressure between the venturi throat and the air in the carburetor
- More susceptible to icing
- The venturi lowers the pressure, which in turns lower the air temperature
- Temperatures of 20 to 70°F with high humidity are favorable for carburetor icing
- Ice will form on the venturi and valve
- The first indication for icing – loss of engine RPM (in an airplane with a fixed pitch propeller)
- First thing to do – apply carb heat
    - First result will be a decreased engine performance because warmer air is less dense so the fuel/air mixture becomes richer
    - Then a gradual increase as the ice melts

Maintenance

- The owner or operator is responsible for:
    - Keeping the airplane in airworthy condition
    - Making appropriate entries in maintenance records (logbook)
        - Logbook must show completion of annual inspection, date, return to service
- Aircraft has to be inspected every 12 calendar months (at the end of the month)
- Rental aircraft used for flight instruction <u>also</u> require 100 hour inspections
    - Can be exceeded by not more than 10 hours, only to reach a place where the inspection is performed. This excess is deducted from the next 100 hours
- Airworthiness Directives (AD) must be indicated in airplane logbook
- A pilot may operate an airplane not in compliance with an AD if the AD allows that
- If an alteration or repair substantially affects the airplane's operation, it must be test flown first (by a private pilot) before carrying passengers

Preventive Maintenance

- Can be done by the pilot. For example:
    - Servicing landing gear wheel bearings
    - Replenishing hydraulic fluid
- Described in 14 CFR part 43.7
- Enter in maintenance records: certificate number, kind of cert held by person approving the work, work description

Required Maintenance

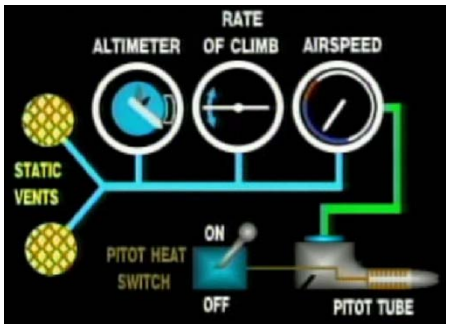
A	Annual - 12 calendar months (must be done by an AI – Authorized Inspector)
V	VOR – checked every 30 days for IFR only
1	100 hours (only for planes flown for hire). Done by an A/P – Airframe/Powerplant mechanic
A	Altimeter – every 24 calendar months
T	Transponder – every 24 calendar months
E	ELT – every 12 calendar months (batteries have to be replaced after 50% of their useful life expires or after 1 hour of cumulative use)

Flight Instruments

Gyro instruments

- Attitude indicator (artificial horizon)
    - The attitude is determined by the relationship of the miniature airplane to the deflecting horizon bar
    - To adjust, align the middle of the miniature airplane to the horizon bar during level flight
    - Vacuum powered
- Heading Indicator (DG, Directional Gyro)
    - Can be used when the compass is bouncing around
    - Needs to be periodically realigned with the compass as it (the heading indicator) precesses
    - Vacuum powered
- Turn Coordinator
    - Indicates turn in the <u>yaw</u> and <u>roll</u> axes
    - The turn is coordinated when the ball is in the middle
    - Electric powered

Pitot/Static Instruments



- The static source is isolated from wingtip vortices and ram effect
- Altimeter
    - A barometer calibrated to show altitude
    - Static source only
- Vertical speed indicator (rate of climb)
    - A bellows with a hole – the air goes in and slowly escapes
    - Static source only
- Airspeed indicator
    - Compares the pressure of the ram (impact) air from the pitot tube with the static source
    - Uses both the static and pitot sources

Altimeter

- Smallest hand – tens of thousands
- Fat short hand – thousands
- Long hand – hundreds
- Round down the small and short hand readings, than add all three up
- Indicated altitude equal true altitude:
    - At field level when the altimeter setting is set to the field's barometric pressure
    - At sea level under standard atmospheric conditions
- **From high to low, look out below!** Failing to reset the air pressure in the altimeter may result in hitting the ground when flying from high to low pressure area. <u>The altimeter will indicate higher than actual altitude</u>
- From low to high, clear the sky! When flying from a low to high pressure area, the altimeter indicates lower than actual altitude
- Setting a bigger number will cause the altimeter to show a bigger reading: 1000' of altitude for each Inch Hg
    - For example, 29->30 Inch Hg changes indicated altitude from 1000'->2000'
- Warm air causes indicated altitude to be lower than true altitude
    - The air is less dense and pressure is higher because the whole atmosphere gets higher over that area
- Conversely for cold air: the true altitude is lower than indicated altitude
- **From high to low, look out below!** holds for temperature changes as well

Altitude

- Indicated altitude – what the altimeter reads
- True altitude (MSL) - how high you are above sea level
- Absolute altitude (AGL) - how high you are above the terrain
- Pressure altitude – how high you are at standard pressure - what the altimeter reads when set to 29.92
- Density altitude - pressure altitude corrected for nonstandard temperature

Compass

- The magnetic compass is only accurate in straight and level, unaccelerated flight
- Magnetic dip is higher the closer you are to the magnetic poles
- Acceleration/Deceleration errors
    - Occur only on easterly and westerly heading
    - **ANDS**: Accelerate North Decelerate South: on an easterly or westerly heading, the compass will turn toward the north when accelerating and south when decelerating
- Turn errors
    - **NO**: North Opposite. On a north heading, when starting a turn the compass will momentarily show a turn in the opposite direction
    - **COSUN** – Compass Overshoot South Undershoot North. The compass overshoots turns while heading south (indicating a greater turn during the turn) and undershoots turns while heading north
- Magnetic deviation errors
    - Caused by magnetic fields inside the airplane

Required equipment for VFR operations (91.205)

- The POH has an equipment list for the particular airplane
- The tail number must be visible
- Standard equipment required for all VFR flights:

Day	**T**	Tachometer
	O	Oil temperature gauge
	M	Magnetic compass
	A	Airspeed indicator
	T	Temperature indicator (only for liquid cooled engine)
	O	Oil pressure gauge
	F	Fuel gauge
	L	Landing gear indicator lights
	A	Altimeter
	M	Manifold pressure gauge (for variable pitch propeller)
	E	ELT
	S	Seat belts / shoulder harness (if manufactured after 1978)
Night	**F**	Fuses – 3 additional sets
	L	Landing lights (only on planes flown for hire)
	A	Anti-collision lights (strobes)
	P	Position lights (red and green nav lights)
	S	Source of power (battery)

MEL – Minimum Equipment List

- A list of items that are allowed to be inoperable
- Inoperable equipment has to be either removed or marked with a placard that says “Inoperable”
- Used primarily by commercial operators

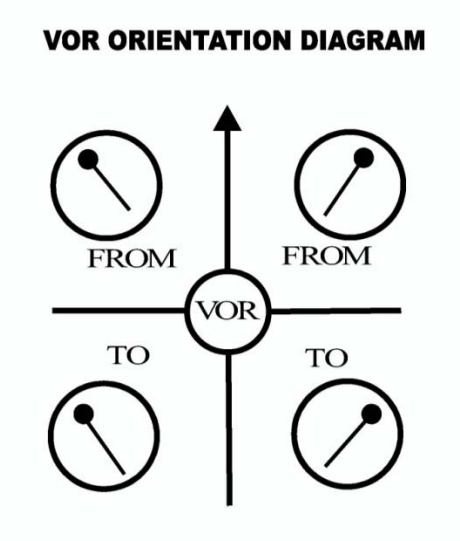
Navigation

ADF – Automatic Direction Finder

- Non Directional Beacon (NDB)
    - Transmits the same signal in all directions
    - Shown on the charts as a circle with a dot in it, surrounded by a circular field of dots
    - Frequency and airport code (in letters and Morse code) marked on the chart
- Magnetic Bearing (MB): The magnetic bearing you’d fly to the station
- Magnetic Heading (MH): The heading of the nose of the airplane

- Relative Bearing (RB): The number of degrees you turn to the right to head to the station
- **MB = MH + RB**
    - *Memory aid – alphabetical order*
- Stationary card: the **arrow is pointing at the Relative Bearing** to the station
    - *Memory aid – SCARB: Stationary Card Arrow Relative Bearing*
- Rotatable card: turn the card until the Magnetic Heading is at the top, and the **arrow will point to the Magnetic Bearing** to the station
    - *Memory aid – RCAMB: Rotatable Card Arrow Magnetic Bearing*
- From the station – 180 degrees off

VOR – VHF Omni Range



- The radial **from** the station is the one you're on
- VORTAC and VOR-DME also show the distance to the station
- The compass rose shown on charts is aligned to magnetic north
- The rotatable card is called OBS – Omni Bearing Selector
- The needle is called CDI – Course Deviation Indicator
- To use a VOR:
    1. Tune to the frequency and verify the Morse code
    2. Set radial in the OBS
    3. Observe the to/from indicator (which also shows neutral and off)
    4. Observe the CDI (needle)
        - When the OBS is set to the station's radial, the needle shows the **direction to turn to** in order to get on course (fly to the needle)
- The direction **to** the station is the reading on the opposite side of the compass rose *(as if flying from the VOR itself toward the compass rose)*
- VOT: VHF Omni Test, radiates a test signal at the 360° radial
    - The needle should be centered when the OBS is set to 360° (From) and 180° (To)
    - *Memory aid - Cessna 182: 180 To*

NDB/VOR Time Check

- While flying on a radial to/from the station, turn 90° to the right or left and note the time
- Fly until the bearing to the station changes by a chosen amount (10° makes the calculation easy)
- Note the time again
- $Time\ to\ Station\ in\ Minutes = \frac{60\ x\ Minutes\ Between\ Bearing\ Change}{Degrees\ of\ Bearing\ Change}$

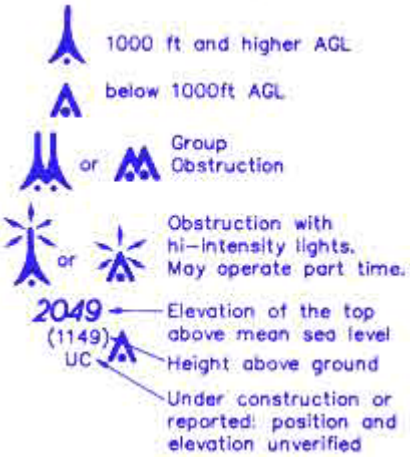
GPS

- 24 satellites
- Minimum of 5 is observable at any time on earth
- Provide longitude, latitude, altitude, and time solution
- A GPS receiver needs 4 satellites for a three dimensional reading

Charts

- Each minute equals 1 nautical mile and spans 1 tick mark
- Sectional charts have a latitude or longitude line every 30 minutes
- Every inch is about 10NM
- Airport – Circle with optional markings inside:
    - Blue – Airport has a control tower. "CT – 118.2*": control tower frequency. The star means the control tower does not operate 24/7
    - Magenta – no control tower
    - R – Private airport

- Line – Hard surface runway at least 1500’ in length, shown at the right orientation
- Tick marks (top, bottom and sides) – Airport is *supposed to* have fuel
- Star on top – rotating beacon
  - Green and white: civilian airport
  - Green and two whites (dual peak white flashes): military airport
  - Green, yellow, white – heliport
- Elevation is shown right below the airport name (MSL)



- Obstructions
  - Bold number shows MSL elevation
  - Number in parentheses shows AGL elevation
- Flag – visual checkpoint to identify your position. Name to be read to ATC is shown next to it
- Contour lines are 500’ of elevation apart

Airspace Restrictions

A	Altitude	• 18,000’ to FL600 in the 48 contiguous states and Alaska
		• ATC keeps track of all aircraft and provides separation service
		• To fly inside class B airspace you must be:
		  • IFR rated and current
		  • IFR equipped
		  • On an IFR flight plan at an altitude assigned by ATC
		  • Equipped with a 4096-code transponder and an encoding altimeter (mode C or mode S)

B	Big, Busy	• Marked by solid blue lines (circles)
		• Each circle is marked with two numbers on top of one another, showing floor (bottom number or SFC for surface) and ceiling (top number) in hundreds of feet MSL
		• To fly inside class B airspace you must:
		  • Get an ATC clearance – they will say “clear to enter class B airspace”
		  • Be a private pilot (students must log flight time in that particular class B airspace and have a logbook endorsement made in the last 30 days)
		  • Have a communication radio
		  • Have a 4096-code transponder and an encoding altimeter (mode C or mode S)
		• VFR pilots don’t need any special NAV equipment, IFR pilots do
		• Must have a transponder in the *mode C veil* – within 30NM of the class B airport

C	Congested, Crowded	• Marked by solid magenta lines • Each circle is marked with two numbers on top of one another, showing floor and ceiling • Inner circle is 5NM in radius and goes up to 4000’ MSL unless otherwise marked • Outer circle is 10NM in radius and goes from 1200’ to 4000’ MSL unless otherwise marked • Outer area is 20NM in radius. Call ATC in this area before entering the outer circle • To enter class C airspace, the airplane must have a 4096-code transponder and an encoding altimeter (mode C or mode S) • Class C services: sequencing, traffic advisories, conflict resolution, safety alerts • Before entering, you must establish two way communication <u>but don’t have to get clearance</u>. If the controller asks you to stay clear of the class C airspace, you must obey • If taking off from a satellite airport within class C, establish communication with the class C tower as soon as is practicable
D	Dialog	• Marked by blue segmented line • Core area radius is 4.4NM (5SM); actual area may be different and is designed for IFR flights • Goes up to 2500’ MSL (inclusive) unless otherwise marked in a boxed number (shown in

		hundreds of feet MSL). Minus sign next to the number means the ceiling does not include the altitude shown
		• Core area extensions beyond 2NM are typically made class E (dashed magenta line)
		• Must establish two way communication and talk to ATC before entering the core area
		  • Must get a clearance to take off and land
		• Airport must have a control tower; airport symbol is blue
		• When tower is not in operation, the area is no longer class D
		  • If weather reporting is available, turns into surface area class E
		  • Otherwise, turns into class G from the surface up
		• The purpose of the control tower is to provide "safe, orderly, expeditious flow", not separation service for VFR in flight (they do provide it on the runway only). They do provide advisories and alerts when getting too close to obstacles
		• If taking off from a satellite airport within class D, establish communication with the class D tower as soon as is practicable

E	Elsewhere	• Blue gradient: (sharp edge on the outside) floor of controlled airspace is 1200' AGL unless otherwise noted next to the gradient. Tire tread line separates the standard floor from the specifically noted one • Magenta gradient: floor of controlled airspace is 700' AGL • If blue gradient is not present, assume floor is 1200' outside of the magenta gradient • Magenta dashed line: floor is ground level (surface area class E) – <u>only when weather reporting is available</u> • No communication or equipment requirements for VFR • Weather minimums are increased in class E • Ceiling is 17,999' • ATC provides advisory on workload-permitting basis
G	Go for it	• Uncontrolled • Beyond the [sharp] edge of other airspace boundaries • Goes from the surface to the floor or any airspace above it or to 14,500' (above which all US airspace is controlled – class E) • Dangerous for IFR operations • Lower weather minimums and distance from clouds • ATC provides advisory on workload permitting basis and when radar and communication coverage is available

Special use airspace

- Restricted area (R-####): military operations like heat seeking missiles and aerial gunnery. Ok to fly in outside of the operation times as published on the charts or by getting a permission from the relevant ATC
- Warning area (W-####): same military operations as in restricted areas, but extend to sea in international water
  - The US can't limit flights there, only warn pilots
- Military Operations Area (MOA): military training activities that involve acrobatic or abrupt flight maneuvers
  - Ok for VFR airplanes to fly in, exercising extreme caution
  - IFR airplanes can't fly in
- Alert area (A-###): typically military student pilot training. All pilots are required to look out the window and exercise caution
- Military training route (IR###): military airplanes flying in these routes at speeds over 250 knots, possibly close to the ground
  - 3 digit number: above or below 1500' AGL
  - 4 digit number: below 1500' AGL
  - VR: only operational in visual conditions
  - IR: can have IFR operations
- National wildlife refuge – request that you maintain a minimum of 2000' AGL

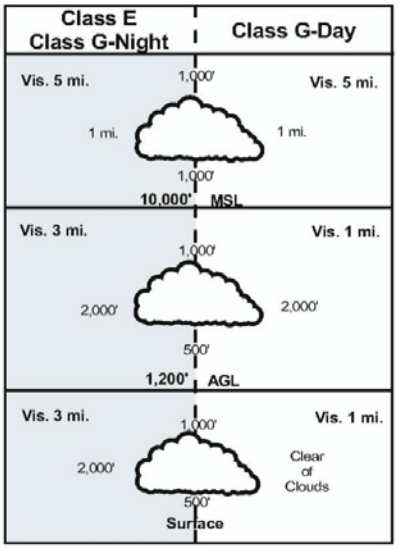
Airways

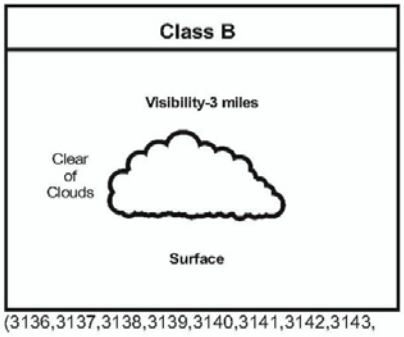
- Airways are controlled (class E) and designed for IFR flights
- Typically 8 miles wide
- Typically from 1200’ AGL to 17,999’ MSL

VFR weather minimums

Airspace	Visibility	Distance from Clouds
Class E & G above 10,000’ MSL and more than 1200’ AGL	5 SM	1000’ below 1000’ above 1 mile horizontal
Class B	3 SM	Clear of clouds
Class C Class D Class E below 10,000’ MSL Class G **night** below 10,000’ MSL	3 SM	500’ below 1000’ above 2000’ horizontal
Class G **day** 1200’ AGL and higher, below 10,000’ MSL	1 SM	500’ below 1000’ above 2000’ horizontal
Class G **day** below 1200’ AGL Class G **night** in a traffic pattern (within 0.5 mile of the runway) Special VFR	1 SM	Clear of clouds
Class B, C, D, E surface area	3 SM	1000’ ceiling or higher

- If the rotating beacon is on during daytime the weather is below VFR weather minimums





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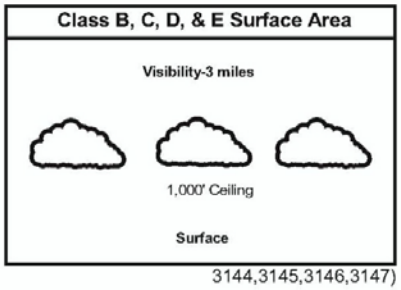

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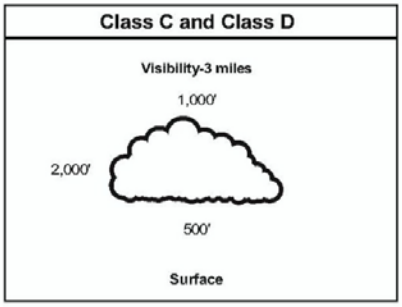


VFR WEATHER MINIMUMS FAR § 91.155		
AIRSPACE	FLIGHT VISIBILITY	DISTANCE FROM CLOUDS
CLASS A	Not Applicable	Not Applicable
CLASS B	3 Statute Miles	Clear of Clouds
CLASS C CLASS D CLASS E	3 Statute Miles	500' below 1,000' above 2,000' horizontal
CLASS E & G At and above 10,000' MSL	5 Statute Miles	1,000' below 1,000' above 1 mile horizontal
CLASS G DAY Above 1,200' AGL	1 Statute Mile	500' below 1,000' above 2,000' horizontal
CLASS G NIGHT Above 1,200' AGL	3 Statute Miles	500' below 1,000' above 2,000' horizontal
CLASS G DAY Below 1,200' AGL	1 Statute Mile	Clear of Clouds
CLASS G NIGHT Below 1,200' AGL	3 Statute Miles	500' below 1,000' above 2,000' horizontal

Communication Requirements and Weather Minimums

	Class A	Class B	Class C	Class D	Class E	Class G
Minimum Pilot Qualification	Instrument Rating	Student*	Student*	Student*	Student*	Student
Entry Requirements	IFR: ATC Clearance VFR: Operations Prohibited	ATC Clearance	IFR: ATC Clearance VFR: Two-Way Communication w/ATC	IFR: ATC Clearance VFR: Two-Way Communication w/ATC	IFR: ATC Clearance VFR: None	None
VFR Visibility Below 10,000 msl**	N/A	3 Statute Miles	3 Statute Miles	3 Statute Miles	3 Statute Miles	Day: 1 Statute Mile Night: 3 Statute Miles
VFR Cloud Clearance Below 10,000 msl	N/A	Clear of Clouds	500 Below 1,000 Above 2,000 Horizontal	500 Below 1,000 Above 2,000 Horizontal	500 Below 1,000 Above 2,000 Horizontal	500 Below 1,000 Above 2,000 Horiz.***
VFR Visibility 10,000 msl and Above**	N/A	3 Statute Miles	3 Statute Miles	3 Statute Miles	5 Statute Miles	5 Statute Miles
VFR Cloud Clearance 10,000 msl and Above	N/A	Clear of Clouds	500 Below 1,000 Above 2,000 Horizontal	500 Below 1,000 Above 2,000 Horizontal	1,000 Below 1,000 Above 1 Statute Mile Horizontal	1,000 Below 1,000 Above 1 Statute Mile Horizontal

*Prior to operating within Class B, C, or D airspace (or Class E airspace with an operating control tower), student, sport, and recreational pilots must meet the applicable FAR Part 61 training and endorsement requirements. Solo student, sport, and recreational pilot operations are prohibited at those airports listed in FAR Part 91, appendix D, section 4.

**Student pilot operations require at least 3 statute miles visibility during the day and 5 statute miles visibility at night.

***Class G VFR cloud clearance at 1,200 agl and below (day): clear of clouds.

Class A

- Class A, NA
- Minimum visibility and cloud clearance requirements are not applicable to Class A airspace, since flight under VFR is not permitted.

Class B

- 3 and Clear
- Visibility must be at least three statute miles. There is no minimum distance from clouds which must be maintained. The airplane must simply be operated so as to remain clear of clouds.

Class C

- 3 Cessna 152's
- Visibility must be at least three statute miles. A distance of 1000 feet above, 500 feet below, and 2000 feet horizontally must be maintained from clouds.

Class D

- 3 152's
- Visibility must be at least three statute miles. A distance of 1000 feet above, 500 feet below, and 2000 feet horizontally must be maintained from clouds.

Class A: Class A, NA
Class B: 3 and Clear
Class C: 3 152's
Class D: 3 152's
Class E and Class G at night

- Above and Including 10,000 Feet MSL: 5 F-111's
- Below 10,000 Feet MSL: 3 152's

Class G during the daytime

- Above and Including 10,000 Feet MSL: 5 F-111's
- Below 10,000 Feet MSL, above 1,200 feet AGL: 1 152
- Below 10,000 Feet MSL, below 1,200 feet AGL: 1 and Clear

Class E day & night and Class G at night

- Above and Including 10,000 Feet MSL
  - 5 F-111's
  - At altitudes at or above 10,000 feet MSL in Class E airspace, visibility must be at least five statute miles. A distance of 1000 feet above, 1000 feet below, and 1 statute mile horizontally must be maintained from clouds.
- Below 10,000 Feet MSL

    - 3 152's
    - At altitudes below 10,000 feet MSL in Class E airspace, visibility must be at least three statute miles. A distance of 1000 feet above, 500 feet below, and 2000 feet horizontally must be maintained from clouds.

Class G during the daytime

- Above and Including 10,000 Feet MSL
    - 5 F-111's
- Below 10,000 Feet MSL but above 1,200 feet AGL
    - 1 152
    - Below 10,000 feet MSL, the weather minimums are more relaxed. VFR weather minimums are 1 statute mile visibility, with cloud clearance requirements of 1000 feet above, 500 feet below, and 2000 feet horizontally.
- Below 10,000 Feet MSL and also below 1,200 feet AGL
    - 1 and Clear
    - Below 10,000 feet MSL and also below 1,200 feet AGL, the weather is further relaxed to allow VFR flight clear of clouds. VFR weather minimums are 1 statute mile and clear of clouds.

Special VFR

- ATC provides separation, like for IFR flights
- Need a special VFR clearance
    - The pilot must request it (flight service can relay the request to ATC)
    - Request has to be approved by ATC
        - Will usually be approved unless IFR operations are taking place (as they have priority)
- Allowed within the lateral boundaries of surface areas of class B, C, D or E airspace up to 10,000' MSL
- Weather minimums:
    - 1 SM visibility, clear of clouds
    - At night – pilot must be IFR rated and plane must be IFR equipped
- If chart says NO SVFR – no special VFR is available

ATIS – Automated Terminal Information Service

- When weather conditions are good (ceiling of at least 5000' AGL and visibility of at least 5 SM), ceiling and visibility will not be included in the ATIS
- Includes only non-control information (information unrelated to traffic control)

Communication

Communication with ground operations

1. Airport name followed by type of operation – one of the following:
    - Radio: Flight Service Stations (FSS)
    - Tower: Control tower
    - Flight Watch: en-route Flight Advisory Service (EFAS)

    For example: RHV Tower
2. Which aircraft you're in

    For example, Diamond 764DC
3. Where you are

    10 miles north of the airport
4. Your intent

    Inbound for landing with Romeo

- Pronouncing numbers:
    - 10,500' MSL: one zero thousand five hundred feet MSL

    - 4,500: four thousand five hundred
- Communication order

Arrival	Departure	Communicate
1	4	Approach – arrival, departure, coordination, traffic advisories
2	3	Tower – takeoff, landing
3	2	Ground – taxi
	1	Clearance delivery – give clearances to IFR and VFR departures (typically in class B, C and sometimes class D as well)

Common frequencies

- 122.2: Flight service ("Radio")
- 122.0: Flight watch en-route (EFAS)
- 121.5: Emergency

Common Traffic Advisory Frequency (CTAF)

- Marked with a "C" in a circle after the frequency in the airport information block on the sectional charts
- When arriving, announce when:
    - 10 miles before the airport
    - On downwind leg
    - On base leg
    - On final leg
    - Clear of runway
- When departing:
    - Announce before taxiing
    - Announce before taxiing onto a runway
    - Monitor until 10 miles from the airport

FSS

- Airport advisory area is within 10 miles of an airport with a Flight Service Station (FSS) but no control tower
- Contact FSS prior to entering for airport information, traffic advisories, weather, NOTAMs, TFRs, and flight plans
- In an airport that has a tower and an FSS, the FSS provides airport advisory service when the tower is closed
- RCO is a communication relay for a remote FSS, indicated by a thick blue box on the charts. The name of the FSS is shown below the box
- Typically available on 122.2 (guaranteed only above 5000' AGL)
- 121.1R on VOR boxes means that the FSS receives on this frequency while the pilot receives on the VOR frequency
- The FSS has equipment that allows them to locate you: VHF/DF (Direction Finding)
    - You can call in and ask for assistance
    - To enable a VHD/DF steer, a VHF transmitter/receiver is the only equipment required on the airplane

Unicom

- Operated by Fixed Based Operations (FBO)
- Can be used to order fuel
- The airport directory lists the frequency, typically 122.8

Transponders

- 1200: transponder squack code – the standard for VFR
- 7700: emergency squack
- 7600: lost communication squack
- 7500: hijack squack
- Don't squack the above three by accident

Radar services

- Clock positions are relative to the airplane's ground track, regardless of crab angle
- Basic radar service:
    - Traffic advisories
    - Safety alerts – when you come too close to another airplane or obstruction
    - Limited radar vectoring
- TRSA: Terminal Radar Service Area
    - Low level service given in a few airports
    - Contact ground control to request
    - Participation is <u>voluntary</u>
        - Sequencing of all IFR and participating VFR aircraft
        - Separation of all IFR and participating VFR aircraft
            - Only 500' of vertical separation, not the standard 1000'
- Class C and B services
    - Participation is <u>mandatory</u>
        - Sequencing of all IFR and VFR aircraft
        - Separation of all IFR and VFR aircraft
            - 500' of vertical separation in class C, greater in class B

Transponder requirements

- 4096 code transponder with encoding altimeter is required in:
    - Class A airspace
    - Class B (and within 30 miles of class B airport in the class B veil)
    - Class C
- Transponder cannot be used unless it has been tested and inspected within the last 24 calendar months

ATC

- Called Approach/Center/Departure
- The frequency can be found in the AF/D
- Provide radar services
    - Flight following
    - Traffic alerts
    - Special VFR at surface class E

En-route weather

- EFAS: 122.0 (guaranteed only above 5000' AGL)

Emergencies

Engine failure

- Immediately establish proper gliding attitude and airspeed
- On a downwind landing, expect a higher groundspeed and longer ground roll
- Maintain a constant glide speed – variation will make it hard to judge gliding distance and landing spot

Overheating

- Excessively high engine temperature can cause:
    - Loss of power
    - Excessive oil consumption
    - Possible permanent internal engine damage
- Can be caused by:

        - Lower than specified fuel octane
        - Operating with too much engine power
        - Mixture set too lean
        - Too low an oil level
            - Reciprocating aircraft engines depend on oil circulation to carry heat out of the engine
- To cool the engine down:
    - Enrich the mixture
    - Pitch the nose down to reduce the rate of climb and increase air speed

Detonation

- Happens when an unburned charge explodes
- Can be very damaging to the cylinder
- Can be caused by using a grade of fuel **lower** than specified
- First corrective action – during climb, lower the nose to increase airspeed

Pre-ignition

- Happens when a charge fires in advance of normal spark ignition
- Can be caused by hot spots in the engine

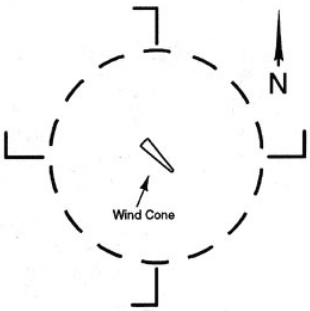
Airport Operations

Glide indicators

- Maintain altitude at or above the glide slope
- VASI: Far light should be red, close light should be white. Red over white, you're alright. Red over red, you're dead (too low). White over white, you'll fly all night (too high)
- Tri-light VASI: yellow/amber (top, too high), green (on correct glide slope), red (too low)
- PAPI: **** too high, **** slightly high, **** on correct glide slope, **** slightly low, **** too low
- PLASI: pulsating white (too high), steady white (on correct glide slope), pulsating red (too low)

Airport lights

- Turn on medium intensity: click the mic 5 times within 5 seconds
- White lights are runways, blue lights are taxi ways
- Runway numbers are orientated to the nearest 10° relative to magnetic north



Pattern

- Segmented circle shows right or left traffic (the direction all turns are to in traffic)
- Enter at 45° at the center of the downwind leg at pattern altitude

Runway signs

Taxiway Direction or Destination	
Destination	
Location "Black square, you're there"	
Mandatory instruction ("Stop!"). This sign is for a holding position: runway 4 is on	

the left and runway 22 is on the right	
No Entry	
Runway boundary *Solid lines – away from the runway*	
Taxiway ending	

Runway markings

Can't land here (ok to taxi/take off)	
Overrun area – no operation allowed (other than overrunning or crashing)	
Closed runway	

Crosswind

- Headwind:
  - Aileron up on side facing wind (point the stick to that side)
  - Tricycle: elevator (stick) neutral
  - Tail wheel: elevator up (pull stick)
- Tailwind:
  - Stick (yoke) to the <u>opposite</u> side facing wind
  - Elevator down (push stick)

LAHSO (Land And Hold Short Operations)

- PIC has final say on participating
- Student pilots can't participate
- Basic VFR required: 1000' clear of clouds, 3 **Statute Miles** visibility

Light gun signals

- If no radio connection: squack 7600, observe traffic, enter pattern, observe light gun
- On the ground:
  - Flashing white: return to your starting point at the airport
  - Flashing green: clear to taxi
- In the air:
  - Steady green: clear to land
  - Steady red: give way and keep circling
  - Flashing red: airport is unsafe for landing
  - Alternating green and red: exercise extreme caution
  - Alternating green and red followed by flashing red: exercise extreme caution, airport is not safe for landing

Aeromedical Factors

Hypoxia

- A state of oxygen deficiency in the body
- Less pressure leads to less oxygen available for breathing

Hyperventilation

- Breathing too hard, caused by emotional tension, anxiety or fear
- Can decrease the amount of oxygen in the body
- Slow the breathing rate by breathing into a bag or talking

CO poisoning

- Can be caused by an exhaust pipe leak
- Can cause loss of muscular power
- Cockpit CO detectors can show CO accumulation
- Higher altitudes make you more susceptible to CO poisoning

Spatial disorientation

- A state of temporary confusion resulting from misleading information being sent to the senses
- The pilot is more susceptible to it if they rely on body signals to interpret flight conditions
- To overcome, relay on the flight instrument indications

Hazards

- Reduce risks associated with flight using:
    - Situational awareness
    - Problem recognition
    - Good judgment
- Hazardous attitudes:
    - Antiauthority
    - Impulsivity
    - Invulnerability
    - Macho
    - Resignation
- Scud running: trying to maintain visual contact with the terrain in low visibility conditions.
- Continual flight into IFR conditions often leads to spatial disorientation

Weather

Weather concepts

- The cause of all weather changes: heat exchange (unequal heating)
- Standard weather (ISA – International Standard Atmosphere)
    - 15°C, 59°F
    - 29.92 Inches Hg, 1013.2 millibars
- Winds from high to low pressure are straight close to the ground due to friction with the ground
- Winds higher up go clockwise around highs and counterclockwise around lows
- Dew point – the temperature to which water must be cooled for the air to be saturated
    - Water will condensate when the air temperature reaches the dew point
- Moisture can be added to the air through evaporation and sublimation
- Temperature and dew point get closer by 4.4^{o}F every 1000’ of altitude

Stability

- Lapse rate: the rate of temperature decrease with altitude
    - Actual lapse rate can be used to determine the stability of the atmosphere:
        - If it gets colder faster than standard, the air is <u>unstable</u>
        - If it gets warmer with altitude or colder slower than standard, the air is <u>stable</u>
        - Standard lapse rate: 2°C per 1000'
- Stable air:
    - Stratiform clouds
    - Steady precipitation
    - Smooth air
    - Fog
    - Poor visibility at the surface
- Unstable air:
    - Good visibility at the surface
    - Cumuliform clouds
    - Showery precipitation
    - Turbulence
    - Warming from below (rising air) decreases the stability of an air mass
    - If the air keeps rising and has moisture in it, it will eventually develop into towering cumulus clouds which indicate convective turbulence

Fronts

- When flying across a front, there will always be changes in wind direction
- Cold front on weather maps: icicles outward
- Warm front on weather maps: half-suns outward
- Stationary front: icicles and half-suns on alternating sides
    - Behaves like warm fronts, but are more quiescent and barely moves. Winds on both sides of a stationary front are often parallel to the front.
- Occluded front: icicles and half-suns on the same side, purple line
    - A cold fronts that catches up or overtakes a warm fronts. Indicative of mature storm systems (about to dissipate)

Weather Hazards

- Structural icing can only form in visible moisture
- Freezing rain
    - The most prone to cause structural icing
    - Caused by temperature inversion at higher altitudes
- Frost
    - Formed when the temperature is at or below the dew point and below freezing
- Temperature inversion
    - Hot air above cold air
    - Formed in clear, calm nights over flat land
    - Smooth air with low visibility
    - Unstable air will destroy the temperature inversion
    - Surface based inversion is most commonly caused by terrestrial radiation on a clear, relatively still night

Fog

- Radiation fog: caused by warm moist air over low flatland areas on clear, calm nights
- Advection fog: caused by moving warm moist air that is cooled down when it reaches colder land. Happens mostly in winter by air coming from the ocean
- Upslope fog: caused by warm air cooling down when it goes up a mountain
- Steam fog: formed in arctic areas above the relatively warm water. Causes icing and turbulence

Cumulonimbus clouds

- Have the greatest turbulence and wind shear
- Become thunderstorm clouds when lightning starts
- Need lifting force, unstable and moist air
- Stages:
    - Cumulus stage: continuous updraft
    - Mature stage: when it starts raining
    - Dissipating stage: downdrafts

Squall line clouds

- A line of clouds ahead of a cold front
- Most dangerous thunderstorms

Wind shear

- Wind shear can occur in all altitudes and all directions
- Most significantly: low-level temperature inversions, frontal zones, clear air turbulence, and next to thunderstorms
- Wind shear in an inversion: happens when there are high altitude winds (at least 25 knots) at 2000-4000' AGL

Standing Lenticular clouds

- On top of ridges
- Form in stable air with 40 knot winds
- Indicates the top of a standing wave
- Expect substantial mountain wave turbulence with winds of 50 knots or more
- Fly above them

Pressure Altitude

- How high you are at standard pressure - what the altimeter reads when set to 29.92
- How high you'll have to fly in a standard atmosphere to get the same pressure
- Equal to true altitude only in standard atmospheric conditions

Density Altitude

- How far apart the molecules are. When they are far apart, the density altitude is high. This is counter intuitive, so it helps to think about it as "performance altitude" – indicating how the airplane will perform
- At 5000' density altitude, the airplane will perform as if it's at 5000'
- Equal to pressure altitude corrected for nonstandard temperature
- Equal to pressure altitude at standard temperature
- When Outside Air Temperature (OAT) increases, density altitude increases
- High temperature, high humidity, and high density altitude decrease airplane takeoff and climb performance, because:
    - There is less air to burn
    - The wings produce less lift
    - Propeller efficiency is reduced

In flight weather advisories

- All advisories are disseminated to all pilot and apply to all aircraft
- AIRMET: weather warnings – icing etc.
    - Sierra: IFR conditions
    - Tango: Turbulence
    - Zulu: Icing
- SIGMET: significant advisories for severe weather

- Convective SIGMET: tornados, embedded (buried) thunderstorms, winds greater than 50kts, hail ¾" or larger

METAR: Current weather report

- Ceiling – the bottom of overcast (OVC) or broken (BKN) cloud layer not scattered (SCT), thin, or partial
- VFR minimum: 1000' ceiling, 3SM visibility
- X gusting to Y: estimated wind is X + (Y – X) / 2

METAR	KSFO	DDHHMMZ	22014G18KT	15SM	SCT150	R04/2200	25/15	A2992	RMK RAB35
Report type **SPECI**: Special	Airport code. K is for US airports	Day and zulu time	Wind coming from 220° true north at 14 knots gusting to 18 knots	15 Statute miles visibility	**SKC**: Sky clear **SCT**150: Scattered clouds at 15,000' **RA**: rain **SH**: showers **SN**: Snow **FG**: fog **BR**: mist (Baby Rain, thin fog) **HZ**: Haze (thin mist) **TS**: Thunderstorm **- (dash)**: light	Runway 04, visibility 2200 feet	Temperature / dew point in °C	Altimeter setting: 29.92	Remark Rain beginning 35 minutes past the hour of this report

- RMK T00221028: Temperature is +2.2°C and dew point is -2.8°C. The first digit in each group of four numbers is the sign – 0 for positive and 1 for negative. The following three digits are the temperature or dew point in tenths.
- RMK SLP217: Sea level pressure is 1021.7hPA (millibars)

Intensity	Description	Precipitation	Weather that reduces visibility	Other weather phenomena
- Light Moderate (no indication) + Heavy VC: Within 10 miles from, but not at the aerodrome.	MI: Shallow BC: Patches PR: Partial, part of runway DR: Drifting BL: Blowing SH: Showers TS: Thunder FZ: Freezing	DZ: Drizzle RA: Rain SN: Snow SG: Snow grains IC: Ice needles PL: Ice pellets GR: Hail GS: Small hail	BR: Mist FG: Fog FU: Smoke VA: Volcanic ash DU: Dust devils SA: Sand HZ: Dry mist, haze	PO: Dust/sand swirls SQ: Squalls FC: Funnel clouds, tornado, twister SS: Sand storm DR: Dust storm

TAF: Weather forecast (Terminal Aerodrome Forecast)

- Issued 4 times a day, usually valid for 24 hours (30 hours for large airports)

TAF	KSFO	DDHHMMZ	2900/2924 - or - 291818	…	PROB40	2202	1SM	TSRA	OVC008**CB**
Report type	Airport code. K is for US airports	Day and zulu time	Valid from the 29th day of the month at 00:00 zulu to the 29th at 24:00 - or - Valid from the 29th day of the month at 18:00 zulu to the 30th at 18:00	(same wind, visibility, and special weather)	40% probability for what's coming next	Between 22:00 and 02:00 zulu	1 statute mile visibility	Thunderstorms and rain	Overcast at 800 feet with cumulonimbus clouds (the only type forecasted on a TAF)

TAF continued

FM2200	VRB06KT	P6SM	BECMG	0608	02008KT	TEMPO	1214	1/2SM	FG
From 22:00 zulu	Wind from variable directions at 6 knots	Visibility better than 6 statute miles	Becoming	Between 06:00 and 08:00 zulu	Wind from 020° at 8 knots	Temporarily	Between 12:00 and 14:00 zulu	½ statute mile visibility	Fog

Wind and Temperature Aloft

- True north, knots, °C
- 2006+03: Wind from 200° (20 times 10) true north at 06 knots, temperature +3°C
- Light and variable wind (less than 5 knots): 9900

Area forecast

- Area forecast spans multiple states; use only if terminal forecast is unavailable

CHIC	FA	DDHHMMZ
Chicago area	Area Forecast	Day and zulu time

- CLDS/WX: Clouds and whether forecast
- OTLK: Outlook
- AIRMET is where you find info about IFR conditions and mountain obscuration
- LLWS: Low Level Wind Shear, TS: Thunderstorm
- Altitudes are given in MSL, unless otherwise noted with AGL or CIL (Ceiling)
- OTLK IFR CIG BR: The outlook is IFR conditions due to a ceiling and mist
- LWR: Lower, UPR: Upper, NRN: Northern, SRN: Southern

Weather charts

- VFR conditions: 3000’ ceiling, 5 SM visibility
  - No contour line
- Marginal VFR: 1000-3000’ ceiling, 3-5 SM visibility
  - Contour line, ceiling (in hundreds of feet) marked next to a circle
- IFR: below marginal VFR
  - Contour line and shading
- Filled circle: overcast. Partly covered – partly clouded
- Ceiling is shown below the circles in hundreds of feet
- Visibility in statute miles shown to the left of the circles (only if less than 5 SM)
- = (equal sign) after visibility number means fog
- •• rain
- •
  ▽ rain showers

Prognostication charts

- Show forecasted weather
- Top panels: significant weather. Bottom charts: pressure systems, fronts, precipitation
- Left panels: 12 hour forecast. Right panels: 24 hour forecast
- Shows areas or IFR and marginal VFR weather
- ———————— IFR areas are surrounded by a smooth line
- ∩∩∩∩∩∩ Marginal VFR areas are surrounded by a scalloped line
- — — — — Moderate or greater turbulence
- ~~~~~~~~~~ Freezing level at surface
- - - - - - - - - - - Freezing level - the number on it is the altitude in hundreds of feet MSL
- Shaded area: precipitation
- ••• continuous rain

- * snow ** continuous snow star above star: intermittent snow star above triangle: snow showers
- —^— moderate turbulence. With cap above – severe turbulence
- Number below turbulence symbol: 180/ : from surface to 18,000'. 180/10 : from 1000' to 18,000'

Pilot reports

- Start with UA
- OV KRHV-KSFO/TM 1800: over the route from RHV to SFO at 18:00 zulu
- FL120/TP BE90: altitude is 12,000' MSL, plane type is BE-90
- SK BKN018-TOP055: sky condition is broken clouds from 1800-5500' MSL (if top is unknown: UNKN)
- OVC072-TOP089/CLR ABV: overcast cloud layer from 7200-8900' MSL, clear above that
- TA M7: temperature is -7°C
- WV 08021: Wind velocity is 21 knots coming from 80°
- TB LGT 055-072: light turbulence from 5500-7200' MSL
- IC LGT-MOD RIME 072-089: light to moderate rime icing *(freezing fog)* from 7200-8900' MSL

Radar reports

- Inner contour lines indicate increasingly intense precipitation
- Numbers indicate tops of precipitation (not clouds) in hundreds of feet. Do not show ceilings
- R: Rain. RW: Rain showers
- Arrows show cell direction, number shows movement speed in knots
- Severe weather watch:
    - Surrounded by heavy dashed line
    - W: severe Weather watch
    - S: Severe thunderstorm
    - T: Tornado

Weather briefing

- To request a weather briefing, say the following:
    - You are a pilot
    - Airplane ID or your name
    - VFR
    - Route
    - Destination
    - Type of aircraft
- Standard briefing: complete weather briefing
- Abbreviated briefing: supplement mass-disseminated data (like the weather channel) or update a previous briefing
- Outlook briefing: if the flight is 6 or more hours in the future

En-route Flight Advisory Service (EFAS)

- Known as "flight watch"
- Provides actual weather, PIREPs and information about thunderstorms along route
- Available at 122.0

In-flight weather services

- Transcribed Weather Broadcasts (TWEB)
    - Weather briefing for specific route
    - Available on VOR or NDB frequency if T is indicated on the top right corner of an info box on a sectional chart (in a blue circle)

- Hazardous In-flight Advisory Weather Service (HIWAS)
    - Available on VOR or NDB frequency if H is indicated on the top right corner of an info box on a sectional chart (in a blue circle)

Regulations

Documents

- Required documents while flying: Pilot certificate, Photo ID, Medical certificate (PPM)
- The following can inspect you: FAA administrator, NTSB, Law enforcement, TSA
- Medical certificate for private pilot: 3rd class medical certificate
- Medical certificate expiration depends solely on age: <40: 5 years. ≥40: 2 years. Expires at end of same month
- Pilot certificate is limited to the category and class it was issued for:
    - Category: airplane, rotorcraft, glider, lighter than air
        - Class (of airplane): single engine land, single engine sea, multi engine land, multi engine sea
            - Type: make and model
    - Type rating indicates the actual type of aircraft. Only required for a plane with a gross weight of more than 12,500 or turbojets
- Aircraft certification is given by category and class:
    - Aircraft categories: normal, utility, acrobatic
    - Aircraft classes: Airplane, rotorcraft, glider, hot air balloon, powered lift (vertical takeoff and landing)
- Restricted category aircraft (like a crop duster) normally cannot fly over populated areas
- Experimental aircraft cannot be operated over congested airways unless authorized
- Experimental or special light-sport aircraft: limitations are attached to the airworthiness certificate
- Documents required on board the aircraft:

A	Airworthiness certificate – comes with the aircraft, never expires
R	Registration certificate
O	Operating limitations – limited speeds etc. • FAA approved flight manual • Approved manual material • Markings • Placards
W	Weight and balance

PPL restrictions

- In order to tow a glider, pilot must have at least 100 hours on the same category, class, and type airplane, and have completed at least 3 simulated or actual tow operations in the past year
- Need ground and flight instruction (simulator ok) + one-time logbook endorsement for:
    - High performance: more than 200HP
    - Complex airplane: retractable landing gear, flaps, controllable prop
        - *Exception – logged PIC time in both before August 4, 1997*
    - Flying above 25,000'
- To carry passengers, must do at least 3 takeoffs and 3 landings in the past 90 days in the same category, class and type airplane. In a tail wheel – landings must be to a complete stop.
- To carry passengers <u>at night</u> - must perform at least 3 takeoffs and 3 landings in the past 90 days in the same category, class and type airplane to a complete stop.
    - Night is between 1 hour after sunset to 1 hour before sunrise (for carrying passengers only)
    - Normal definition of nighttime (not applicable for carrying passengers): from end of evening civil twilight to beginning of morning civil twilight

PPL privileges

- Share expenses (must be equal or pro-rated)
- Carry passengers for a charitable organization
- PIC is in charge – may deviate from regulations in case of an emergency without submitting a report (unless asked by the FAA)

Biannual flight review

- Must get logbook endorsement of flight review or pilot proficiency check within preceding 24 calendar months (at the end of the month)

Right of way

- An aircraft in distress has the right of way over all other aircraft
- If two aircrafts are converging:
    - Same category – the aircraft on the **right** has the right of way
    - Different category – the less maneuverable aircraft has the right of way
        - Airplanes and helicopters are considered the same for this purpose
        - Airplanes towing or refueling have the right of way over all other engine-driven aircraft. Gliders and balloons are not engine driven, so they have the right of way
    - When a sea-plane and a boat are converging, the one on the right has the right of way
- On landing approach, the lowest aircraft has the right of way (but can't take advantage of that)

Night operations

- Lights on from sunset and sunrise
- Left wing: red light
- Right wing: green light
- Tail: white light
- Top/bottom: flashing red anti-collision light
- Front: white landing light
- Wing lights are blocked so you can't see them from behind the aircraft

Flight operations

- Must follow FAA established pattern when departing an uncontrolled airport
- Prior to starting a maneuver, must scan the entire area for traffic - especially before climbing or descending
- Formation flight is only allowed with prior arrangement between the pilots

ATC clearance

- ATC clearance gives you the right to proceed (but not separation from other aircraft or priority over them)
- Read back taxi instructions
- A taxi clearance to a particular runway gives you permission to cross other runways but not to enter the runway you are taxiing to
- Hold short before crossing a runway or entering the assigned runway, wait for further instructions
    - ATC will say "Line up and wait"
- Don't switch over and contact ground control until the control tower specifically tells you so
- TCAS I and TAS alerts the pilot of dangerously close aircraft
- TCAS II alerts and also provides resolution advisories – how much to climb or descend
- Can't deviate from an ATC clearance unless:
    - You get an amended clearance (pilot can ask for one, but not necessarily get it)
    - In an emergency
    - You respond to a resolution advisory in an aircraft equipped with a TCAS II
- If you deviate from ATC clearance in an emergency and are <u>given priority over other aircraft</u>, you must submit a detailed report within 48 hours to the chief of the ATC facility even if no rule has been violated – <u>only if ATC asks for it</u>

Vertical separation above 3000' AGL

- 0-179° magnetic course: odd thousand +500' MSL (3500', 5500', 7500', etc.)
- 180-359° magnetic course: even thousand +500' MSL (4500', 6500', 8500', etc.)

Speed limits

- No speed limit:
    - At or above 10,000’ MSL
- 250 KIAS (Knots Indicated Air Speed):
    - Below 10,000’ MSL
- 200 KIAS:
    - Within 4 NM of a class C or D airport and up to 2500’ AGL
    - Under class B or in a VFR corridor through class B

Safety belts

- Crew members must have their seatbelts fastened throughout the flight
- Shoulder harness must be fastened only during takeoff and landing
- Passengers should have their safety belts fastened during taxi, takeoff, and landing
    - Does not apply to children 2 years or younger or to skydivers

Oxygen

- Between 12,500’ and 14,000’ MSL: crew must use supplemental oxygen if there for more than 30 minutes
- Above 14,000’ MSL: crew must use supplemental oxygen
- Above 15,000’ MSL: passengers have to be provided with supplemental oxygen (but don’t have to use it)

Minimum altitudes

- Anywhere: safe altitude should allow an emergency landing without harming others
- Above a non-congested area: 500’ AGL minimum
- Above open water or sparsely populated area: 500’ from any object (close to the water is fine)
- Above a congested area: 1000’ AGL minimum above any obstacle within 2000’ horizontally

Aerobatic flight

- An intentional maneuver involving an abrupt change in an aircraft’s attitude, an abnormal attitude, or abnormal acceleration, not necessary for normal flight (FAR 91.303). Another definition: intentionally pitching the nose up or down at least 30°
- Not allowed:
    - Within the surface areas of class B, C, D, and E airspace
    - On a federal airway (class E) below 1500’ AGL
    - With less than 3 mile visibility
    - Over any congested area
    - Over an open air assembly of people (air shows have waivers for low altitude acrobatics)
- Each occupant must wear an approved parachute
- Chair type parachute must have been packed within the preceding 120 days

Emergency Locator Transmitter (ELT)

- Analog – transmits on 121.5 and 243.0MHz (military). Monitored by other airplanes and ATC
- Digital – transmits on 121.5 and 406MHz. Monitored in addition by satellites
- Batteries have to be replaced after 50% of useful life expires or after 1 hour of cumulative use
- To ensure the ELT hasn’t been activated, monitor 121.5 before engine shutdown
- Analog ELT can be tested during the first 5 minutes after the hour
- Digital ELT should only be tested by a technician

NTSB notification:

- Notify the NTSB immediately about all accidents and incidents
- Accidents – <u>must</u> submit a report within 10 days
- Incidents – submit a report only if asked about:
    - Overdue aircraft believed to be involved in an accident
    - Inability of a flight crew member to perform their duties

    - Flight control system malfunction
    - Fire in an aircraft
    - Separation or release of propeller blade in flight
    - Loss of information from more than 50% of an electronic display (glass cockpit). Flickering doesn't count
    - Failure of turbine engine component resulting a escape of debris other than out of the exhaust
- Wreckage can only be moved to protect it from further damage

Hand propping

- The person at the controls in the cockpit must be a pilot

Alcohol

- Can't act as a crew member **8** hours after drinking or with .04% or more blood alcohol
- Passenger can be under influence only in a medical situation under proper care or in an emergency
- Report to the FAA civil aviation security division is <u>required</u> within 60 days of conviction in:
    - Driving under influence
    - Being involved in an accident involving alcohol
- Certificate may be suspended or revoked for violating laws related to drugs and for operating an aircraft under influence

Mailing address

- Must notify the FAA within 30 days after changing an address

Dropping objects

- Objects can be dropped if precautions are taken to prevent damage to property and people

Flight Planning

Flight planning

- Become familiar with all available information concerning the flight
- Determine runway length at airports intended for use
- Have an alternate plan
- Fuel requirements:
    - Day: enough for flight to the destination + 30 minutes at normal cruise speed
    - Night: enough for flight to the destination + 45 minutes at normal cruise speed

Flight Plan

- Cruising altitude: initial altitude, ignoring altitude changes
    - ATC may assign an altitude¸ but it's unknown when planning the flight
    - FSS does not assign an altitude
- Destination: the final, not en-route destination. Use airport code and city, nothing else
    - If planning to be more than an hour on the ground, file a separate flight plan
- Fuel on board: <u>usable</u> fuel on board in hours and minutes
- Close flight plan with a FSS or another FAA facility after landing

Airport/Facility Directory (A/F D)

- Left-hand traffic is standard, only non standard (right-hand) traffic is marked
- A/F D shows the airport code (item 3) and location relative to the town (item 4, distance and direction)

Flight Computer

- "How fast" always comes first
- Miles / Gallons are always on the outer scale

- Minutes are on the inner scale
- When done calculating, ask “does it make sense?”
- It’s much easier to use a calculator for speed and GPH calculations (MPH=M/H, GPH=G/H. H=m/60)

Magnetic Variation

- VAR: Magnetic Variation - The difference between true course to magnetic course
- MC: Magnetic Course - Course referenced to magnetic north
- TC: True Course - Course referenced to true north
- Heading - The direction the nose of the airplane is pointed
- MH: Magnetic Heading - The direction the nose is pointed referenced to magnetic north
- WCA: Wind Correction Angle - The angle from which the wind is coming from, relative to your heading. The difference between course and heading
- Wind direction is always given relative to true direction, except for on a runway where it’s given in magnetic direction
- DEV: Deviation - Error in compass due to magnetic fields in aircraft, the difference between magnetic heading and compass heading
- CH: Compass Heading - The number you see in the compass
- TAS: True Airspeed - The speed of the aircraft through the air
- GS: Ground Speed - The speed of the aircraft over the ground – TAS corrected for wind
- GT: Ground Track - The track the airplane “draws” on the ground. Equals to TC (True Course)
- Isogonic lines - lines of equal magnetic variation. Shown as red dashed lines on sectional charts
- Agonic line - An imaginary line on the earth's surface connecting points where the magnetic declination is zero
- **East is least, west is best** - subtract easterly variation, add westerly variation.

Heading calculations

- TH = TC +/- WCA (TC is measured on chart)
- MH = TH +/- VAR
- CH = MH +/- DEV
- ETE: Estimated Time En-route
- TETE: Total Estimated Time En-route

Weight and Balance

- Moment = Weight * Arm
- CG = Total moment / Total weight
- Fuel weights 6lb per gallon
- Unusable fuel and undrainable oil are included in the weight of the airplane
- Utility category – CG range in which extreme maneuvers are allowed

Advisory Circular

- General information for pilots
- Available from the government printing office
- Covers different topics:
    - **60**: Airman (certification and such)
    - **70**: Airspace (conditions etc.)
    - **90**: Air traffic control and general operations

NOTAMs: Notices to Airmen

- FDC NOTAMs: notifications about regulatory changes, instrument approach changes, chart changes
- NOTAM (D): notifications about airport and airport facilities
- NOTAM (L): lower priority notifications; don’t exist anymore
- NOTAMs with short effective period are sent with weather briefings

- If they remain valid for at least 7 days, they are published in the Notices to Airmen publication
    - Includes NOTAM (D) and FDC NOTAMs

Preflight

- Use the manufacturer's checklist
- The Pilot In Command (PIC) is responsible for determining that the aircraft is safe for flight (airworthy)
- The mechanic is responsible for making sure the aircraft is airworthy when the work is done
- The owner or operator is responsible for maintaining the aircraft in an airworthy condition
- Fill up the gas tanks at the end of the day to eliminate airspace which can result in moisture condensation
- Drain fuel from all available drains – including fuel strainers and fuel tank sumps
- If recommended octane is unavailable, use the next <u>higher</u> octane of aviation gas

Calculating Pressure Altitude

Correct <u>field elevation</u> for <u>pressure</u> to get pressure altitude

- To have the altimeter read pressure altitude, set it to 29.92
- Pressure altitude = (29.92 – current pressure setting) * 1000 + field elevation

Calculating Density Altitude

Correct pressure altitude for <u>temperature</u> to get Density Altitude

- Density altitude = Pressure altitude + 120 * (OAT^{o}C – Standard temp. at the level of the pressure altitude in ^{o}C)
- For example:
  Pressure altitude = 2315
  OAT = 4°C
  Standard temperature at the level of the pressure altitude = 15 - 2 * 2315 / 1000 = 10.37^{o}C
  Density altitude = 2315 + 120 * (4 – 10.37) = 1550.6

Calculating beginning of descent distance

- On a Diamond DA-20:
    - Descend at 500'/minute, 1000'/5NM, at cruise speed: BOD distance in NM = Altitude to lose x 5 / 1000
    - Glide ratio (power off): 1000'/1NM

Flight Operations

Positive aircraft control

- Order of operations:
    a. Pitch
    b. Power
    c. Trim
- Pitch controls altitude
- Power controls airspeed

Altimeter setting

- First choice: set the local altimeter setting
- If unavailable, set to the departure airport's elevation
- Above 18,000': always set to 29.92

Standard rate of turn

- Standard rate of turn in degrees: IAS / 10 + 5°

Lost procedure

1) Circle

2) Climb
3) Cross check 2 VORs for location
4) Communicate
5) Confess
6) Comply

Emergency procedures

- Engine out:
    - Airspeed: Vg (73kts on a Diamond)
    - Identify the best landing spot and maneuver towards it
    - Perform emergency checklist
    - Squack 7700
    - Communicate on 121.5 or last com frequency
    - Before landing: perform the before-landing checklist
- Lost generator:
    - Fly to a class D or E airport
    - Squack 7600
    - Conserve power – turn off unnecessary equipment
    - Go to 1000' above pattern altitude or 2000' AGL
    - Circle, rock wings
    - Look for light gun signals

Flight maneuvers

- The four fundamental maneuvers:
    - Straight and level flight
    - Turns
    - Climb
    - Descent
    - When landing, keep the longitudinal axis of the airplane at the direction the airplane is going to reduce load on the landing gear

Collision Avoidance

- Daytime
    - Perform a series of short regularly spaced eye movements to search each 10 degree sector
    - Systematically stop and focus on parts of the sky looking for traffic
    - An aircraft on a collision course shows no apparent relative motion
    - Haze can make all terrain features appear further away than they really are
- Night time
    - Use peripheral vision (off center viewing: look at the side of the object)
    - Scan slowly
    - Avoid bright white lights at least 30 minutes before the flight
- Most air collisions happen on clear days
- Always let the controller know when you're at an intersection

Climb

- On a Diamond DA-20:
    - Cruise climb: 80-85kts, 500'/min, 2 fingers above lever flight
    - Best rate (Vy): 700'/min, 75kts, 3 fingers above lever flight
    - Best angle (Vx): 1000'/min, 58kts, 6 fingers above lever flight

Spin recovery

P	Power – idle

A	Ailerons – neutral
R	Rudder – opposite
E	Elevator – forward

Descent

When at	Do	Communicate
Beginning of descent	Light – landing Fuel pump – on Mixture – rich	
10 miles out		Placerville traffic, Diamond 764DC 10 miles <relative direction> for landing Placerville

Approach to unknown airport

When at	Do	Communicate
1000' above pattern altitude (typically 2000 AGL)	Circle counterclockwise above airport, observe windsock and segmented circle	Placerville traffic, Diamond 764DC 2000' above airport for landing Placerville
Wind and pattern direction determined	Fly out perpendicular to runway on pattern side, descending at 500'/min to pattern altitude	
Pattern altitude	Teardrop turn (270°) to 45°	Placerville traffic, Diamond 764DC landing runway 23 entering on the 45 midfield Placerville
Pattern distance	45° turn to downwind	Placerville traffic, Diamond 764DC on downwind runway 23 Placerville

Takeoff/Landing

When at	Do	Communicate
Before entering runway	Pre-takeoff checklist	Placerville traffic, Diamond 764DC on runway 23 for a left crosswind departure Placerville
Takeoff	Full throttle, right rudder when airborne	
400 AGL	Flaps up to cruise position	
500 AGL	Turn to crosswind	Placerville traffic, Diamond 764DC turning crosswind runway 23 Placerville
Numbers at 45°	Turn to downwind	Placerville traffic, Diamond 764DC turning to downwind runway 23 Placerville
Pattern altitude (typically 1000 AGL)	Pitch down, 1900 RPM	
Abeam numbers	One notch of flaps, throttle to idle, descend at 500'/min	
Numbers at 45°, only when traffic is abeam on final	Turn to base Flaps one notch down as required	Placerville traffic, Diamond 764DC turning to base runway 23 Placerville
500 AGL	Turn to final, watch VASI and correct by pitching down or adding power. Alight to runway with rudder, turn with ailerons	Placerville traffic, Diamond 764DC turning to final runway 23 Placerville
20' above runway	Nose up to level flight, float above runway until right before	

	touchdown	
Right before touchdown	Nose further up, lower gradually	
Clear of runway (beyond solid line)	Stop, post-landing checklist	Placerville traffic, Diamond 764DC clear of runway 23 Placerville
Touch-and-go	Full throttle, right rudder, flaps up one notch to T/O position (may be there already depending on landing type)	Placerville traffic, Diamond 764DC going around on runway 23 Placerville

Slow flight

When	Do
Before starting	Perform the before-landing checklist
Start	Power down to 1500RPM
	Maintain level flight
	1st notch of flaps
In the white arc	2nd notch of flaps
At 60kts	Pitch 2 fingers above level flight
	Power up to 1800RPM
	Trim

Power-off stall

When	Do
Before starting	Enter slow flight
Start	Close throttle
	Maintain altitude
	Use rudder for direction control
Stall occurs (buffeting, shaking, mushy controls, loud horn)	Reduce angle of attack
	Full throttle
	Use right rudder to correct direction
After recovery	Pitch up
	Clean up (flaps to cruise position)
	Return to original attitude and cruise configuration

Power-on stall

When	Do
Start	Power down to 1500RPM
	Maintain altitude
	Adjust pitch attitude
At 60kts	Pitch up
	Power up
	Use right rudder to correct direction
Stall occurs (buffeting)	Reduce angle of attack
	Return to cruise climb and keep climbing

Soft field takeoff

When	Do
Before entering runway	Elevator back
Entering runway	Enter and align quickly with no breaks

On center line	Full throttle
	Elevator back
Nose wheel up	Elevator slowly down until floating in ground effect
At 70kts	Elevator back
	Cruise climb

Short field takeoff

When	Do
Before taking off	Position at the edge of the runway – on the threshold
	Hold the breaks
	Full throttle
Starting to roll	Let go of the breaks
	Rotate at 50 – steep rotation (cowl is 2 fingers above the horizon)
Obstacle cleared (50ft AGL)	Pitch down and climb at Vy

Soft field landing

When	Do
Touching down	Touchdown as slow as possible (around 55kts)
After touchdown	Hold elevator back
Taxiing off the runway	Hold elevator back
	Turn and exit runway with no breaks if possible

Short field landing

When	Do
Turning base	Flaps to landing position
	Glide at 60kts
On final	Aim before the threshold
	Maintain 60kts
On short final	Maintain 55kts
After touchdown	Breaks
	Elevator back
	Flaps out

Forward slip

When	Do
In the pattern	Slightly wider pattern
On downwind and base	Maintain altitude
Prior to final	Flaps to landing position
On final	Full rudder
	Opposite aileron
	Nose down