

COMMERCIAL PILOT CERTIFICATE STUDY GUIDE



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Released www.FlyWithTizi.com v1.0

For Reference & Review Only

Requirements to act as PIC

Documents

FAR 61.3

- Pilot Certificate (signed)
- State-Issued Photo ID
- Appropriate Medical Certificate

Flight Review (every 24 calendar months)

FAR 61.57

- Can't fail a flight review
- Same content as check ride
- Includes with proficiency and currency plans.
- Can take more than one per cycle

Currency to carry Persons (every 90 days)

FAR 61.57

- Need to be current to carry persons, not just passengers to **act as PIC**
- Day: 3 TO/LDGs to minimum TnG
- Night: 3 TO/LDGs to minimum SnG at least 1 hour after *sunset* to 1+00 before *sunrise*. You can carry passengers up to 1+00 after *sunset* and still be legal.
-

Instrument Currency

FAR 61.57

- **6** instrument approaches
- Holding procedures
- Intercepting &
- Tracking courses
- IPC required after 12 months

Logging Requirements

FAR 61.51

- To demonstrate aeronautical experience for new rating or recent flight experience
- Not required to carry logbook but must be able to provide proof of currency "upon reasonable accommodation". Offer to provide a scan or photo when you get your logbook.

Commercial Pilot Privileges

FAR 61.133 & AC 120-12A

Privileges

- Carry persons or property for compensation or hire
- Can perform **private carriage** for hire not involving holding out. You can advertise you're a commercial pilot but cannot provide an aircraft. Carriage services for one or several selected customers, cannot be too many that will indicate holding out.

Limitations

- **Instrument rating** required for XC > 50 NM or night passenger operations
- Cannot perform **common carriage** of passengers or cargo.
- Common carriage involves "holding out" (advertising through signs, publicity,

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reputation, livery, etc.) to the public as willing to offer **pilot with aircraft services**.

- Cannot act as an **air carrier**. If you offer your services with an aircraft, you're acting like a mini airline, which is Part 121.
- **Common carrier** characteristics:
 1. A holding out or willingness to
 2. transport persons or property
 3. from place to place
 4. for compensation

Aircraft Certification Categories

Normal

- +3.8g / -1.52g
- MTOW = 12,500 lbs
- Max Seating = 9

Utility

- +4.4g / -1.76g
- MTOW = 12,500 lbs
- Max Seating = 9

Acrobatic

- +6.0g / -3.0g
- MTOW = 12,500 lbs

Limited

- Specific to aircraft

Transport

- MTOW > 19,000 lbs
- Max Seating > 19
- Multiengine aircraft

Airworthiness Requirements

FAR 61.23

Airworthiness Certificate

FAR 61.23

- Must be visible to passengers and crew
- Indefinite validity as long as aircraft is maintained in airworthy condition as defined by airworthiness directives and certification regulations (e.g., Part 23).
- Becomes invalid if registration expires (both registration and airworthiness have a 12 month grace period)

Required Inspections

FAR 91.207, 409, 411, 413

- **Annual Inspection** (12 months). Must be done by Airworthiness Inspector (IA)
- **VOR Check** (30 days if intended for use)
- **100 hour inspection** (if for hire)
- **Altimeter Inspection** (24 months)
- **Transponder Inspection** (24 months)
- **ELT Inspection** (12 months; battery must be replaced when used for >1hr consecutive use or ½ useful life)
- **Supplemental: Airworthiness Directives**

Airworthiness Directives (AD)

FAA Order 8040.1

- FAA directives with new requirements to maintain airworthiness of an aircraft
- Three main types:
 1. **Simple**: Notice of Proposed Rule Making - NPRM). Proposals only, comments open to the public. Eventually becomes a Final Rule.
 2. **Final Rule**: Immediate effect but comments still open.
 3. **Emergency**: Immediate effect due to urgent matters.

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Special Flight Permits

FAR 21.197

- Permission to execute a specific flight to a specific destination for the purposes of repairs, alteration, maintenance, or storage
- E.g., AD requiring a MX shop at another location; moving aircraft to a museum
- Managed and issued by the FSDO

Pilot-Executed Preventative Maintenance

Part 43.12

- "Simple or minor preservation operations and the replacement of small standard parts not involving complex assembly operations" (Part 1.1)
- E.g., Adding oil to the engine, Changing tires

Required Equipment

91.205

- Day VFR: ATOMATOFLAMES
- Night VFR: Day VFR + FLAPS
- IFR: Day + Night VFR + GRABCARD

Inoperative Equipment

91.213

- "Everything needs to work"
- Three options:
 1. **Fix it.** Requires MX log
 2. **Remove it.** Requires MX log and new weight & balance profile.
 3. **Defer it.** Placard it 'INOP'. Can fly with it inop as long as it is not required by:
 - Conformity. Consult the Type Certificate Data Sheet (TCDS), also known as Comprehensive Equipment List.
 - Airworthiness Directives
 - Airplane Flying Manual (AFM)
 - Minimum Equipment List (MEL)
 - 91.205 (ATOMATOFLAMES)
 - Kinds of Equipment List (KOEL)

- Determined to be required by PIC for safety of flight. *"If the pilot ain't vibin', I ain't flyin'"* – A. Barr

Minimum Equipment List (MEL)

- Specifies whether flight can be executed with specific equipment inop.
- Specifies total number of items vs. required (e.g., landing light has 15 LEDs, only need 13 operational)
- Specifies MX deadline requirements (e.g., must be fixed within 5 flights)
- Certified by the FAA

Kinds of Operations Equipment List (KOEL)

- List of equipment required for specific kinds of operations (e.g., VFR Day, VFR Night, IFR Day, IFR Night).

System, Instrument, and/or Equipment	Kinds of Operation (Continued)				Remarks, Notes, and/or Exceptions
	VFR Day	VFR Nt.	IFR Day	IFR Nt.	
Ice & Rain Protection					
Alternate Engine Air Induction System	1	1	1	1	
Alternate Static Air Source	1	1	1	1	
Pitot Heater	—	—	1	1	
Landing Gear					
Wheel Pants	—	—	—	—	May be removed.

Example of Cirrus SR20 G6 KOEL

Medical Certificates

FAR 61.23

First Class Privileges

- PIC / SIC of ATP operations under part 121 (airlines)

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Second Class Privileges

- Commercial Operations
- SIC of ATP other than part 121

Third Class Privileges

- Student, Recreational, Private
- Flight Instructor (only commercial ops)
- Practical Test (DPE)
- BasicMed may substitute this

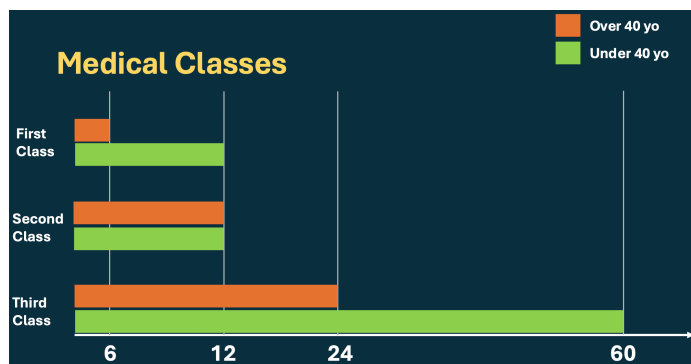
BasicMed Basics

FAR 61.113

- Alternative to medical certificate
- Issue by general doctor
- Must have held a medical in the past
- Limited to <6 occupants (5 passengers max)
- Limited to MTOW < 6,000 lbs
- Cannot enter class A airspace
- Speed < 250 KIAS
- Appropriate logbook entries
- Can be safety pilot not acting PIC

Medical Certificate Validity

FAR 61.23



Required Preflight Information

FAR 91.213

- NOTAMs
- Weather Information
- Known ATC Delays
- Runway Lengths of intended use
- Alternates, if required
- Fuel Requirements
- Take-off and Landing Distance (TOLD)

Risk Management

Safety Approach

- Not the absence of errors but the presence of capacity
- Human vs. System Performance
- **Risk Mitigation.** What can I do to reduce the overall risk of a flight?
- **Safety Culture:** fostering an environment that promotes safety.
- **Crew Resource Management (CRM):** The effective and efficient use of all resources available to you, inside and outside of the cockpit.
- **Single-Pilot Resource Management (SRM):** CRM applied for single pilot ops. What tools are available to you: heading bugs, notepads, etc.



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Hazardous Attitudes & Antidotes

- Anti-authority – Follow the rules. They are usually right.
- Impulsivity – Not so fast. Think first.
- Invulnerability – It could happen to me.
- Macho – Taking chances is foolish.
- Resignation – I'm not helpless. I can make a difference.

Currency vs. Proficiency

- **Currency**: holding the legal requirements to fly; not related to competency.
- **Proficiency**: being competent and ready for the flight.
- Pilots need to be current and feel proficient.

Approaching a Flight – “Big Picture”

- **Pilot**. Current, proficient, healthy, etc.
 - **Illness**
 - **Medication** (see FAA website)
 - **Stress**
 - **Alcohol** (0.04% / 8+00 bottle to throttle)
 - **Fatigue** (acute and chronic)
 - **Emotions**
- **Aircraft**. Airworthy, familiar, etc.
- **Environment**. WX, familiarity, FBO, etc.
- **External Pressures**. Get-there-it is
- **TEAM Checklist**
 - **T**ransfer: should someone above me make this decision?
 - **E**liminate: remove the hazard
 - **A**ccept: Accept benefits vs. costs
 - **M**itigate: lower the risks.
- **DECIDE Model**
 - **D**etect: identify the problem
 - **E**stimate: determine if you need to act
 - **C**hoose: find the best action
 - **I**dentify: identify the solution
 - **D**o: execute your actions

- **Evaluate**: see if it worked well

Personal Minimums

- Dynamic based on proficiency level
- First flight after rating should be “Clear Skies” to gradually approach risk
- Recognition that minimums change is a key factor in risk management

Weather

- Flight into Known Icing (**FIKI**). Most small GA airplanes are not certified for icing conditions, even though they may have anti-icing conditions (e.g., Cirrus)
- **De-icing** systems: Remove ice from airframe (e.g., boots / heating elements)
- **Anti-icing** systems: Prevent icing formation (e.g., anti-ice fluids)
- **Thunderstorms**: avoid them by 20 NM on the upwind side
- **Onboard Weather Radar** (WXR)
 - Live situation ahead of the airplane
 - Show precipitation only
 - May be obscured by cells (i.e., cannot see what is behind a storm)
- **Datalink Weather**
 - Uploaded (e.g., FIS-B)
 - Overall big picture without WXR limitations of coverage
 - Data may be delayed
- **Flight Service Station** (FSS)
 - Limited Remote Communication Outlets (RCOs)
 - See nearest NAVAID for frequency
 - Most coverage >5,000 ft AGL
 - Most common freq = 122.2

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Resources Available to Pilots

- FAA Flight Standards District Office (FSDO) & FAA Inspectors
- AOPA Pilot Services & Pilot Protection Services
- Aviation attorneys
- FSS

Weather Systems

Atmospheric Stability

- Describes movement of air: rise and build storms, sink and clear the skies, or nothing.
- Dependent on dry and saturated adiabatic lapse rates (temperature change with altitude)
- Adiabatic: heat is neither added or lost from the system
 - Dry Adiabatic Lapse Rate: $3^{\circ}\text{C} / 1000\text{ ft}$
 - Saturated Adiabatic Lapse Rate: $1.5\text{-}3^{\circ}\text{C} / 1000\text{ ft}$
 - Averaged out to $2^{\circ}\text{C} / 1000\text{ ft}$

Wind

- Movement of air caused by the uneven heating of the earth's crust by the sun.

Temperature

- Measure of the average kinetic energy of air molecules (fast = hot, slow = cold)
- **Standard day temperature** = 15°C
- *Standard temperature in engineering* = 25°C
- **Standard Lapse Rate** = $2^{\circ}\text{C} / 1000\text{ ft}$
- **Dew Point (DP)**: Temperature of air that needs to be cooled to reach a relative humidity of 100%

Moisture/Precipitation

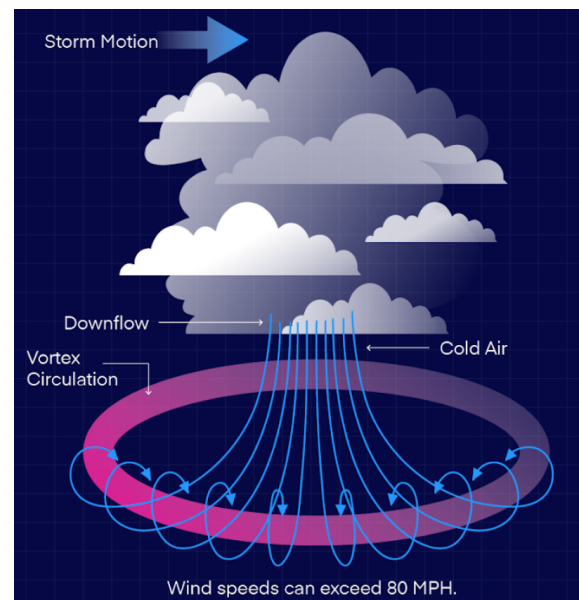
- Relative Humidity: the amount of moisture in the air compared to what the air can "hold" at that temperature.

Thunderstorms

- Also referred to as convective activity
- **Ingredients** for a thunderstorm
 1. Unstable atmosphere
 2. Moisture
 3. Lifting Action (rising air)
- **Three stages** of a thunderstorm
 1. Cumulus (building)
 2. Mature (peak anger)
 3. Dissipating (loss of energy)

Microbursts

- Area of ~ 1.5 square miles with strong downdrafts reaching 6,000 ft/min and 80mph winds
- Wind shear, turbulence, loss in performance
- Severe threat to life
- Can last up to 15 minutes
- Found under a thunderstorm



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Turbulence

- Air motion exhibit chaotic behaviors in flow direction and velocity
- **Light Turbulence:** Momentary erratic changes in altitude / attitude.
- **Moderate Turbulence:** Changes in altitude / attitude / airspeed but aircraft stays in positive control.
- **Severe Turbulence:** Violent changes in altitude / attitude / airspeed and aircraft may momentarily be out of control. Crew and passengers may get injured.
- **Extreme Turbulence:** Aircraft impossible to control, can cause structural damage

Icing

- **Known Icing:** situation where ice formation is detected or observed (e.g., PIREP)
- **Known Icing Conditions:** situation where ice formation is likely expected by a reasonable pilot based upon all available information
- Several types of icing
 1. **Induction Icing:** Carburetor and/or intake icing
 2. **Structural Icing:** ice building on wings that affect aerodynamics and structural geometries
 - Rime Ice: rough milky white ice
 - Clear/Glazed Ice: clear sheet, hard to see
 - Mixed Ice: Mix between rime and clear
 3. **Instrument Icing:** Pitot-static icing can occur on the pitot tube or static ports affecting instrumentation readouts.

Frost

- Coating or Deposit of ice that form on various surfaces in humid cold air

Fog

- **Radiation Fog:** when the ground cools to the adjacent air's dewpoint. Typical with clear skies, calm winds, small temp and dew point spread.

Warm > Cool

- **Advection Fog:** when warm moist air moves over colder ground or water. Typical in coastal areas

~~~~~  
**Warm > Cool**

- **Steam Fog:** When cold air moves over warm water & when moisture evaporates and it immediately condenses in the cooler air

-----  
**Cool > Warm**

- **Precipitation Induced Fog:** Warm moist air is lifted over a front.
- **Upslope Fog:** Moist stable air is forced up a mountain or hill cooling it adiabatically to the air's dewpoint.
- **Ice Fog:** Water droplets suspended in the air freeze into small ice crystals.

### Clouds

- **Cumulus:** White puffy clouds with embedded turbulence
- **Stratus:** layer of clouds with uniform properties
- **Nimbus:** Addition of rain (e.g., nimbostratus; cumulonimbus)
- **Cirrus:** Wispy clouds at high altitudes
- **Calculating Cloud Bases:**

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$$Bases = \left[ \frac{\Delta T^{\circ}\text{C}}{2.5} \times 1000 \right] + \text{field elev}$$

$$Bases = \left[ \frac{\Delta T^{\circ}\text{F}}{4.4} \times 1000 \right] + \text{field elev}$$

$\Delta T$  is the diff between OAT and dew point

## Cold Front

- A body of cold air moving across a wide area.
- Unstable air (lifting force)
- Showery Precipitation
- Cumulus Clouds
- Thunderstorms
- Good visibility
- “Florida Storms in the afternoon”

## Warm Front

- A bod of warm air moving across a wide area.
- Stable air (no lifting force)
- Steady precipitation
- Warmer Temperatures
- Statiform Clouds
- “London, UK weather”

## Stationary Front

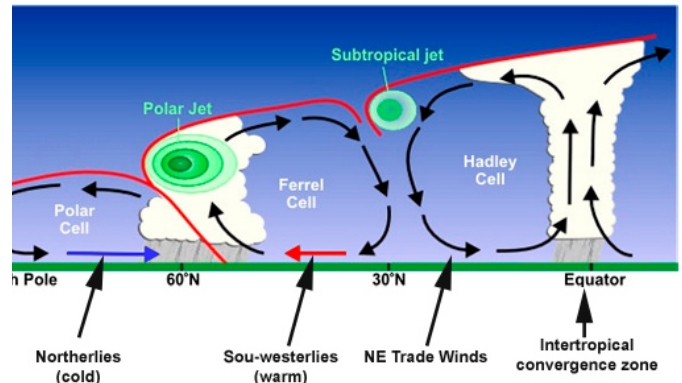
- A body of air that stays in one position for a long period of time
- Characteristics of both cold and warm fronts
- Significant air or freezing rain if lots of water vapor in the atmosphere

## Occluded Front

- A fast moving cold front that reaches a slow moving warm front
- Exhibits first warm front weather followed by cold front weather
- Occlusion is where the two fronts meet

## Jet Streams

- Narrow variable band of strong westerly air currents encircling the globe.
- Subtropical area at 30 degree latitude
- Polar Jetstream in the mid-latitudes
- Winds >60 kts reaching 100-300 kts
- Often carry Clear Air Turbulence (CAT)



## Weather Products / Services

### Sources

- National Weather Service (aviationweather.gov)
- Flight Service Stations (1800wxbrief.com)
- Electronic Flight Bag (EFB): Foreflight or Garmin Pilot

### Reports

- **METAR**: Meteorological Aerodrome Report
  - Valid for moment of observation
  - Issued based on weather system (some collect data continuously, others every 30 min, etc.)

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## STUDY GUIDE

- **ATIS:** Aerodrome Terminal Information System
  - Includes weather (METAR) and other important information for the airfield (NOTAMs, special instructions, etc.).
  - Issued every hour
  - Valid for moment of observation
  - Has a letter designation and must be reported to ATC to either taxi or approach the field.
  - **SPECI** observation issued when conditions change drastically before the new ATIS is issued
- **AWOS:** Automated Weather Observation System
  - The pilot cannot override the AWOS. If it's reporting IFR, then must treat the airfield as IFR.
- **TAF:** Terminal Aerodrome Forecast: Forecast issued every 6 hours and valid for 24 hours (sometimes 30). Not at all facilities have TAFs.
- **PIREP:** Pilot Report made while airborne
  - UA: Routine PIREP
  - UUA: Urgent PIREP (e.g., Low Level Wind Shear)
- **Prognostic Chart:** Big picture chart for entire US depicting pressure systems, fronts, etc. to provide a wholesome view of the weather and forecasts.
- **CWA:** Center Weather Advisory
  - Unscheduled in-flight advisory used by crews to avoid adverse weather conditions that is becoming a SIGMET (WS) or Convective SIGMET (WST)
  - Valid for up to 2 hours
- **G-AIRMET:** Graphical Airman's Meteorological Information
  - Weather advisory for conditions hazardous to VFR traffic, single engine aircraft, and other light aircraft.
  - Found on EFB or AWC's Graphical Forecasts for Aviation (GFA Tool)
- Replaced the textual AIRMETs in 2010 (Zulu, Tango, Sierra)
- Updated every 3 hrs, valid for 3 hr intervals, up to 12 hrs
- **SIGMET (WS):** Significant Meteorological Information
  - Weather advisory for severe weather conditions that affect safety of flight for any aircraft.
  - Issued when needed, valid for 4 hrs, sometimes for 6 (volcanic ash, hurricanes)
- **Convective SIGMET (WSA):** Significant Meteorological Information specific to thunderstorm activity
  - Convective activity is so dangerous that it's issued hourly to confirm also when conditions don't exist.
  - Assigned designation N through Y (except S and T), like ATIS
  - Issued every hour and valid for 2 hrs

### General Airspaces

#### Class A

FAR 91.135

- Flight levels (18,000 ft – 60,000 ft)
- Requires IFR clearance
- Requires Mode C and ADS-B out
- Requires DME above FL240

#### Class B

FAR 91.131

- Typically surface to 10,000 ft AGL
- Requires two-way radio comms
- Requires clearance for VFR traffic
- Requires Mode C and ADS-B out
- Requires operable VOR or RNAV system for IFR traffic

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## Class C

FAR 91.130

- Typically surface to 4,000 ft AGL
- Requires two-way radio comms
- Requires transponder and ADS-B out

## Class D

FAR 91.129

- Typically surface to 2,500 ft AGL
- Requires two-way radio comms

## Class E

FAR 91.127

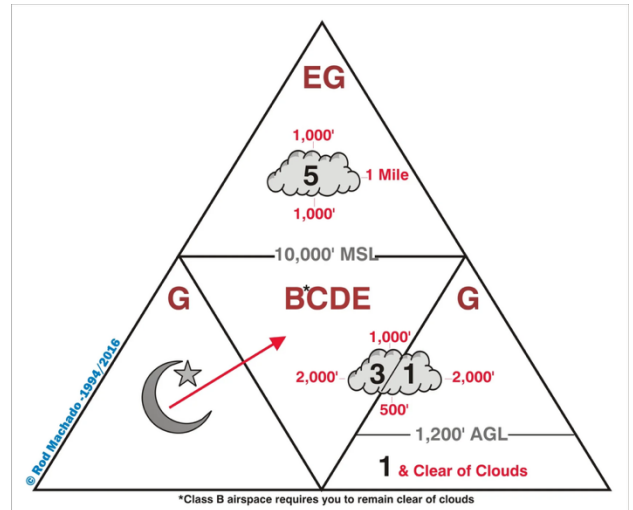
- Begins at 14,500 ft MSL up to 17,999 ft MSL, and then again at FL600
- Around US, faded blue line brings the airspace down to 1,200 ft AGL
- Faded magenta line brings down to 700 ft AGL
- Dashed magenta line brings down to surface
- Requires transponder and ADS-B out above 10,000 ft MSL

## Class G

FAR 91.126

- Uncontrolled airspace
- Inverse faded blue excludes class E
- Filler airspace
- Generically from surface to 1200 ft AGL
- Requires Mode C and ADS-B above 10,000 ft MSL and greater than 2,500 ft AGL (e.g., mountain)

## Airspace VFR Requirements

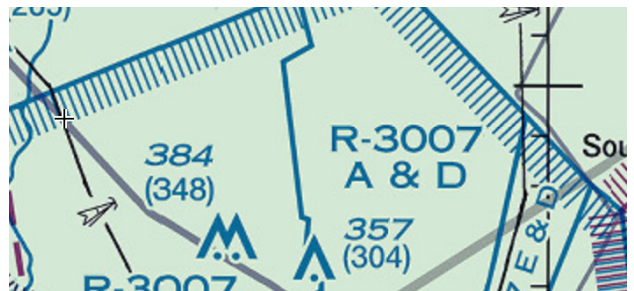


## Special Use Airspace

### Restricted Areas

FAR 73.13

- Cannot operate unless *cleared* by controlling agency.
- Typically controlled by military; when cold may revert to civilian control (e.g., nearby TRACON)
- Blue borders with 'R' designation (e.g., R-3007)



# COMMERCIAL PILOT CERTIFICATE STUDY GUIDE

## Prohibited Areas

FAR 73.83

- Cannot operate unless *authorized* by controlling agency.
- Typically controlled by military or government (e.g., White House, Nuclear Submarine base)
- Blue borders with 'P' designation (e.g., P-50)

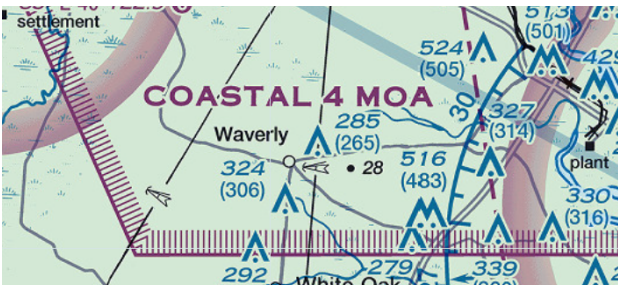


## Warning Areas

- Found off the coast (3 NM outward)
- Typically controlled and used by military (e.g., Eastern seaboard near GA and FL is "Sealord")

## Military Operations Areas (MOA)

- VFR traffic can enter without authorization/clearance but should exercise caution.
- Designed to separate military activities from IFR traffic.
- Magenta border with full name (e.g., Bulldog or Coastal 4)



## Controlled Firing Areas (CFA)

- Contain activities (civilian and military) that could be hazardous to aircraft (e.g., shooting rockets, exploding bombs, etc.)
- Not charted, NOTAM'd, reported, etc. A pilot would never know if they're approaching one.
- Personnel on ground halt all activities if aircraft approach.
- So why should I care? I don't know.

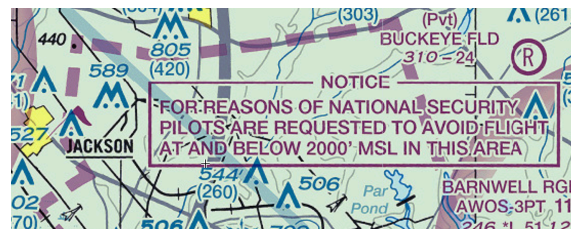
## Alert Areas

- High volume pilot training areas.
- Most often found off the coast
- Famous one near CLT
- Magenta borders with 'A' designation (e.g., A-531)



## National Security Areas

- Airspace relevant to national security
- Pilots are asked to voluntarily avoid
- Charted with magenta dashed line and notice box (e.g., East of KAGS)



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## Other Airspaces / Routes

### Military Training Routes (MTR)

- High speed military training at low altitudes
- IR designates instrument routes
- VR designates VFR routes
- Four number designations = <1,500 ft AGL
- Three number designations >1,500 ft AGL

### Temporary Flight Restrictions (TFR)

- Flight prohibited except with clearance from controlling agency
- Used for multiple reasons (e.g., VIP, presidential)
- Also used to limit presence of aircraft where and a hazard is present and an accident would compound that hazard.

### Parachute Jump Area

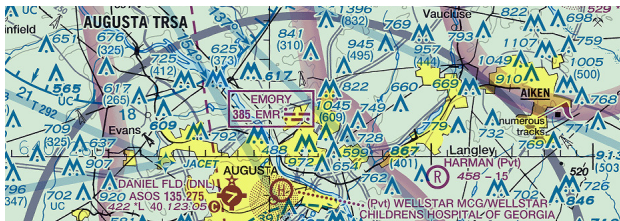
- Known area of parachute jumping operations
- Typically yellow dashed line on EFBs

### Published VFR Routes

- Published VFR routes to allow easier transition through complex airspace (e.g., class B)
- Also referred to as VFR Flyways

### Terminal Radar Service Area (TRSA)

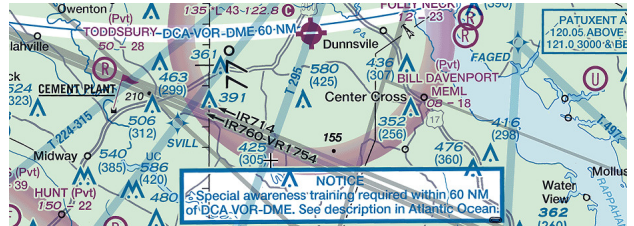
- Voluntary terminal control provided for airspace that is close to class C traffic volume
- Behaves exactly like class C without being one
- You can ignore it, if you like, but will participate if you're on flight following
- Grey borders (e.g., KAGS)



### Special Flight Rules Area (SFRA)

#### FAR Part 93

- Airspace with special rules
- Often requires dedicated training
- Washington D.C. SFRA



## Performance

### Atmospheric Variables

- **Temperature:** Lower temperature means higher air density, which increases performance (i.e., “more air for wings to use”)
- **Pressure:** Higher pressure increases density, which increases performance
- **Humidity:** More humidity increases the air density by replacing air molecules, in turn decreasing performance. Engine performance is reduced due to less oxygen in the air.
- **Elevation:** Higher elevation airports will have higher density altitude, decreasing engine and wing performance, resulting in longer takeoff and climb distances.
- **Density Altitude:** pressure altitude corrected for nonstandard temperature. A measure of how “thick” the air is. E.g., A density altitude of 5,000 ft means that where you are, the air density is as if you were at 5,000 ft. A function of pressure, temperature, and humidity.

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### Aircraft Loading (CG location)

- **Stability:** Tendency of the aircraft to return to trim after an external perturbation. Nose down tendency (FWD CG helps) is considered positive stability.
- **Control:** Ease of the pilot to displace the aircraft from trim. The opposite of stability.
- **Maneuverability:** Extent of maneuvering before structural damage is encountered.
- **Maneuvering Speed:** Stall speed at max gross weight at max loading for that aircraft. With a single control surface full deflection, the aircraft will stall before it breaks. A stall is a 1g maneuver that unloads the aircraft. Stall is better than structural damage.
- **Forward CG**
  - Slower cruise speed (more induced drag at the tail)
  - More fuel consumption
  - Better stall recovery
  - Increased stability
  - Decreased maneuverability
  - Lower chance of spins
  - Increased stall speed
- **Aft CG**
  - Higher cruise speed (less induced drag at the tail)
  - Less fuel consumption
  - Worst stall recovery
  - Decreased stability
  - Increased maneuverability
  - Higher chance of spins
  - Decreased stall speed

### Weight & Balance (W&B)

- Dangers above Weight Limits
  - Decreased aircraft performance
  - Structural integrity concerns
  - Controllability concerns

- Outside of certification/safety envelope
- All aircraft have maximum takeoff weight (MTOW)
- Some aircraft have maximum landing weight (MLW)
- Fuel burn may affect your W&B, so should calculate projected landing weight and how it goes through your CG envelope
- W&B is managed in terms of moments
- **Moments:** a measure of a force's tendency to cause a body to rotate about a specific point or axis (Force x Arm)
- **Arm** (or moment arm): specific reference point about which a moment acts. The arm is provided in the POH for areas where weight can be added (fuel, front passengers, back passengers, baggage, etc.).
- **Datum:** a specific point from which moment arms are calculated (Pipers often use the tip of the propeller, other Cessnas use the location of the firewall). It's the "zero" point for arms. The location is irrelevant as long as all arms are based off of it to make the math work.
- **Weight Shift Formula**

$$\frac{\text{Weight shifted}}{\text{Total Weight}} = \frac{\Delta CG}{\text{Weight Shift Dist}}$$

Example:

$$\frac{20 \text{ lbs}}{2,368 \text{ lbs}} = \frac{\Delta CG}{50 \text{ in}}$$

$$\Delta CG = \frac{20 \text{ lbs}}{2,368 \text{ lbs}} \times 50 \text{ in} = 0.42 \text{ in}$$

# COMMERCIAL PILOT CERTIFICATE STUDY GUIDE

## Basic Aerodynamics

### Lift (L)

$$L_{\text{lift}} = C_L \times \frac{1}{2} \rho v^2 S$$

The diagram shows the lift equation with color-coded labels:  $C_L$  is labeled 'Angle of Attack' in red;  $\rho$  is labeled 'density' in green;  $v^2$  is labeled 'speed' in red; and  $S$  is labeled 'wing surface area' in blue. A purple line points to  $C_L$  with the label 'wing shape'.

- Upward force that makes wings fly
- Caused by **pressure differential** above and below the wing
- Flow accelerates over the wing due to the shape of the airfoil and **continuity law**
- Pressure drops due to **Bernoulli's principle**
  - Lift can be changed by altering angle of attack (which changes  $C_L$ ), increasing airspeed ( $V$ ), or increasing the surface area ( $S$ ), like deploying flaps.
  - The entire airplane contributes to lift, not just wings (fuselage, etc.)
  - The tail is typically a symmetric airfoil or an upside down wing since it typically produces a downforce.

### Weight

- Force due to the mass of the airplane affected by gravity
- Opposes lift
- For straight and level flight, **Lift must equal weight**
- Combined load of aircraft structure, fuel, cargo, and crew/passengers
- Changes with time due to burning fuel

### Drag

- Force due to the resistance of the airplane flying through air.
- For constant speed flight, **thrust must equal drag**.
- Various types, including profile and induced drag.

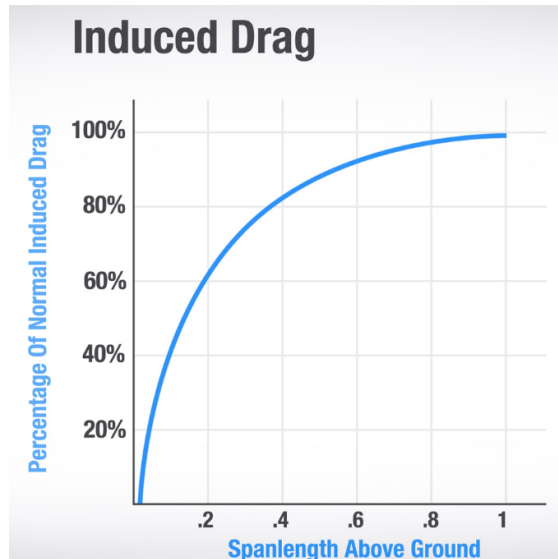
### Thrust

- Force generated by the powerplant.
- Propeller driven airplanes typically measure thrust as a function of power (e.g., 75% BHP).
- Turbine driven airplanes typically measure thrust as a function of actual thrust (e.g., 25,000 lbf)

### Ground Effect

- Phenomenon where an aircraft experiences a reduction in aerodynamic induced-drag when they are close to the ground.
- Induced drag reduction is also supported by wing tip vortices bouncing off the ground
- Cushion of air that makes an airplane float
- Can illude the pilot that they are producing a lot of lift
- Vortices off the tail also bounce back on the horizontal surfaces causing a nose-down tendency. Stick forces can be larger in the flare

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## Adverse Yaw

- Tendency of an aircraft to yaw in the opposite direction of a roll.
- Caused by the downward deflecting aileron increasing induced drag more than the upward deflecting aileron.
- Many airplanes use differential ailerons

## Left Turning Tendencies

- **Torque:** The engine's propeller spins clockwise (as seen from the pilot), causing the airframe to want to rotate counterclockwise (left roll).
- **Spiraling Slipstream:** The propeller generates a slipstream that spirals around the fuselage and impacting the left vertical tail surface, causing a yaw to the left.
- **P-Factor:** The downward spinning propeller side has a higher angle of attack, generating more thrust than the upward spinning side. The right side of the propeller produces more thrust than the left side (as seen from the pilot), causing a left yaw.
- **Gyroscopic Precession:** Typical in tail draggers. When the tail moves up (e.g., takeoff), a force is

generated at the top of the propeller which is rotated 90° in the direction of rotation, causing the resulting force to be on the right side of the propeller (as seen from the pilot) and causing a left yaw.

## **Oxygen Regulations for Part 91** (FAR 91.211)

*Note: All altitudes are **cabin pressure** altitude*

### 12,500 ft MSL to 14,000 ft MSL

- Minimum crew must use oxygen if staying more than 0+30 at those altitudes

### 14,000 ft MSL to 15,000 ft MSL

- Minimum crew must use oxygen at all times

### 15,000 ft MSL and above

- Minimum crew must use oxygen
- Each occupant must be provided with oxygen (i.e., pilots *must* use it, passengers *must* have it available and *may* choose to use it)

### FL250 and above

- Aircraft must have at least a 10-minute oxygen supply *beyond* the amount required for the previous requirements. This is for emergency situations.

### FL350 and above

- At least one pilot *must* wear an O2 mask
- If aircraft has a quick-donning oxygen mask system, then below FL410 this requirement is voided. However, if one pilot leaves the cockpit, then the other pilot must wear the mask.

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## Oxygen Regulations for Part 135 (FAR 135.89)

### Unpressurized Aircraft

*Note: All altitudes are **cabin pressure** altitude*

- Each pilot must use oxygen
  - between 10,000 ft MSL – 12,000 ft MSL if staying more than 0+30 at those altitudes
  - above 12,000 ft MSL

### Pressurized Aircraft

- Each pilot must use oxygen
  - Cabin altitudes above 10,000 ft MSL
  - When *operating* between 25,000 ft MSL – 35,000 ft MSL unless each pilot has a quick-donning mask system
  - When *operating* above 25,000 ft MSL, one pilot must wear it if the other leaves the cockpit.
  - When *operating* above 35,000 ft MSL, at least one pilot must use oxygen at all times

## Oxygen Systems

### Continuous Flow

- Constant flow through cannula or rebreather mask
- Cannulas and rebreather masks do not provide a face-tight seal to protect from cabin air
- **Cannulas** can be worn up to 18,00 ft MSL
- **Rebreather mask** can be worn up to 28,000 ft MSL

### Diluter Demand

- Face-tight seal oxygen mask to avoid cabin air mixing with oxygen supply.
- Oxygen supplied with respiration (as you breathe in) and not continuously

- Required between 28,000 ft MSL - 40,000 ft MSL

### Pressure Demand

- Pushes pressurized oxygen into your lungs with respiration (breathe in) and not continuously
- Required above 40,000 ft MSL

## Pressurized Aircraft

*Note: Pressurization is part of the Environmental Control System (ECS)*

### Source of Pressurization

- Air is pressurized into the cabin via **bleed** air
  - Bleed air from the engine if turbine-powered aircraft
  - Bleed air from the turbocharger if piston-driven aircraft
- **Outflow Valve** (OFV) regulates pressure to control the rate at which cabin pressurized air escapes the aircraft. Also allows for fresh air recirculation (e.g., Gulfstreams have 100% fresh air)
- The **vacuum relief valve** regulates depressurization when the aircraft descends faster than the pressurization system can handle (outside Pressure is higher than cabin Pressure)
- The (emergency) **dump valve** rapidly releases cabin pressure into the atmosphere. Used during emergency procedures.

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## Differential Pressure

- As aircraft gets pressurized, there is a difference between outside air pressure and internal air pressure.
- Structure must sustain the pressure differential
- Pressurized aircraft have a maximum pressure differential (e.g., a PC-12 is 5.75 psi)
- The pressure relief valve prevents structural damage
- Pressurized aircraft have a minimum pressure differential (e.g., a PC-12 is 0.6 psi) to open the door after landing

## Pressurization Schedule

- Most advanced aircraft have an automated pressurization schedule (rate of pressurization and initial altitude of pressurization)
- Some aircraft allow the pilot to select the schedule (at what altitude to start pressurizing and the rate of that pressurization)
- The outflow valve (OFV) is used to manage the schedule

## Systems

*Know your airplane!*

## Primary Flight Controls

- **Aileron**: rotation about the longitudinal axis causing a rolling motion
- **Elevator**: rotation about the lateral axis causing a pitching motion
- **Rudder**: rotation about the vertical axis causing a yawing motion

## Secondary Flight Controls

- **Flaps**: Trailing edge high lift devices that increase surface area and lower stall speed, allowing aircraft to fly at lower speeds during takeoff and landing. They also generate drag, easing speed control.
- **Trimming Devices**: Allow pilots to reduce the control stick force required to maintain a specific speed. Various types exist (trim tabs, anti-servo tab, etc.)
- **Spoilers & Speed Brakes**: Surfaces on the wings that block airflow increasing drag and decreasing lift. They also allow for more downforce on the wheels, increasing brake effectiveness.
- **Slats**: High lift devices on the leading edge of the wing. They delay the stall to higher angles of attack.

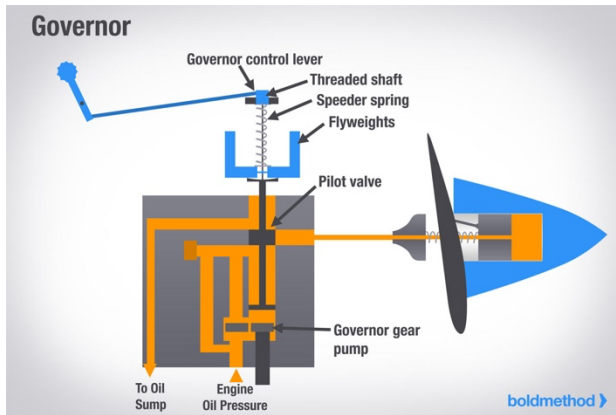
## Powerplant

- Make/Model: \_\_\_\_\_
- Horsepower: \_\_\_\_\_
- Oil quantity: \_\_\_\_\_
- **Horizontally Opposed**
- **Air Cooled**
- **Naturally Aspirated**
- **Direct Drive**

## Propeller

- Make/Model: \_\_\_\_\_
- Constant Speed Propeller (Variable pitch): the goal is to set a given RPM and manifold pressure and the prop blade angles move to accommodate that RPM given the density of air. Think of it like a gear control in a car.

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## Landing Gear System

- Weight on Wheels (WOW) switch
- Actuation (mechanical, hydraulic, electrical, etc.)
- $V_{LE}$  – max speed with gear extended
- $V_{LO}$  – max speed to lower the gear
- Emergency: Follow the checklist!

## Fuel System

- Total Fuel: \_\_\_\_\_
- Usable Fuel: \_\_\_\_\_
- Tabs: \_\_\_\_\_
- Fuel rates in various stages of flight
- Best Range: \_\_\_\_\_
- Best Endurance: \_\_\_\_\_

## Electrical System

- **Master Switch:** opens/closes the switch for the entire system
- **Alternator:** Alternating Current (AC); less MX; less electromagnetic interference (EMI); cannot function without operating battery
- Volts: \_\_\_\_\_ Amps: \_\_\_\_\_
- **Generator:** Alternating (AC) or Direct Current (DC); does not produce current at low RPMs; lower amperages; heavy/bulky; more MX (bearings to grease, clean, etc.); can produce more noise that affects avionics (electromagnetic interference – EMI); not sensitive to electrical

spikes or reversed polarity; can operate when battery is dead.

- **Overvoltage Relay:** Turns off the alternator when voltage spikes
- Battery Volts: \_\_\_\_\_ Amps: \_\_\_\_\_
- **Voltage Regulator:** holds constant voltage to prevent spikes.
- **Main Bus:** Know what's on it.
- **Avionics Bus:** Know what's on it.
- **Non-Essential Bus:** Know what's on it.
- **Avionics:** Know what you have.
- **De-Ice Systems** (examples)
  - Carb Heat
  - Windshield defrost
  - Pneumatic deice boots
- **Anti-Ice Systems** (examples)
  - Weeping wings (e.g., Cirrus)
  - Bleed air heated surface (e.g., Gulfstream)
  - Electrically heated surface

## **Aeromedical Factors (Human Factors)**

### Hypoxia

- **Hypoxic:** Not enough oxygen to the brain (e.g., climbing too high)
- **Hypemic:** Red blood cells cannot carry oxygen
- **Histotoxic:** The tissues cannot consume the oxygen
- **Stagnant:** Insufficient blood flow (e.g., g load)

### Hyperventilation

- Breathing too fast
- Too little CO<sub>2</sub> in the bloodstream
- Body constricts blood vessels so also oxygen has trouble moving
- Can cause loss of consciousness