***NORTH AERO***

AVIATION SERVICES · KSNS SALINAS, CALIFORNIA

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# *PRIVATE PILOT* *WORKBOOK*

## VOLUME 1 · FUNDAMENTALS · LESSONS 1-11

Companion to the Lesson Checklist Book and Reading Guide · Curriculum 5.1

Airplane Single-Engine Land · PA-28-151 Warrior · FAA-S-ACS-6C

The essential content of every assigned FAA reading, condensed for study, with regulations and key definitions quoted word for word. Every source citation is a live link to the FAA original.

Student: ________________________

Instructor: ______________________

**BEFORE YOU BEGIN**

# *HOW TO USE THIS WORKBOOK*

Each chapter carries the substance of that lesson's assigned reading, drawn from and cited to the current FAA publications. It is written for the night before your flight: read the chapter, answer the review questions in writing, and bring anything that did not make sense to the preflight briefing.

**Quoted passages are verbatim.** Anything in a shaded quote block is the FAA's exact language, mostly regulations and definitions worth knowing word for word. Everything else is condensed from the source cited under each heading.

**Every citation is a link.** On a phone, tablet, or computer, tap any source line to open the FAA original: the exact handbook chapter, AIM section, or regulation. When something here makes you curious, the full story is one tap away.

**This workbook is a floor, not a ceiling.** It will get you to the lesson prepared. The Reading Guide points to the full chapters, and the checkride oral rewards the pilot who read them. Aircraft-specific numbers such as V-speeds always come from the Warrior POH, never from this book.

*Answers to every review question are in the key at the back. Write your answer down before you look.*

## THE SHELF, ONE TAP EACH

The publications this volume draws from, linked to their FAA homes:

Pilot's Handbook of Aeronautical Knowledge, FAA-H-8083-25C (2023)

Airplane Flying Handbook, FAA-H-8083-3C (2021)

Aviation Weather Handbook, FAA-H-8083-28B

Aeronautical Information Manual (current, Change 2, eff. 1/22/2026)

Federal Aviation Regulations, Parts 61 and 91 (eCFR, always current)

Stall and Spin Awareness Training, with Changes 1 and 2

Pilots' Role in Collision Avoidance (2022)

**LESSON 1** · **PAIRS WITH GROUND MODULES 1A + 1B + 1C**

# *Introduction to Flight*

*This is your first lesson. You will meet the airplane. You will learn how we decide if it is safe and legal to fly. You will watch the engine start and taxi, and you will get your hands on the controls in flight. This chapter gives you the ground knowledge behind all of it. You will learn what flight training is building toward. You will see how the student pilot path works. You will pick up the safety habits we start on day one. And you will learn the risk management tools we use before every single flight.*

**MEMORY AID** · **FAA**

### PAVE

*A preflight checklist that divides the risks of every flight into four categories so nothing gets skipped.*

P: Pilot in command. Am I ready for this trip? Check experience, recency, currency, and physical and emotional condition.

A: Aircraft. Is this the right airplane? Can it carry the load, use the runways with an adequate margin, and carry sufficient fuel with reserves?

V: enVironment. The conditions surrounding the flight. Weather is a major environmental consideration.

E: External pressures. Influences outside the flight that create pressure to complete it, often at the expense of safety.

PHAK 25C, Ch 2, The PAVE Checklist

**MEMORY AID** · **FAA**

### IMSAFE

*A personal checklist that screens your physical and mental readiness before every flight.*

I: Illness. Am I sick?

M: Medication. Am I taking anything that might affect judgment or make me drowsy?

S: Stress. Am I under pressure from job, money, health, or family problems?

A: Alcohol. Have I been drinking within 8 hours, or within 24 hours?

F: Fatigue. Am I tired and not adequately rested?

E: Emotion. Am I emotionally upset?

PHAK 25C, Ch 2, Mitigating Risk (IMSAFE Checklist)

## WHAT FLIGHT TRAINING IS BUILDING TOWARD

**SOURCE** AFH FAA-H-8083-3C, Ch 1, Introduction + Role of the Flight Instructor

The purpose of primary flight training is to build and sharpen basic airmanship skills. Airmanship is a broad term. It means sound knowledge of the principles of flight. It means the skill to operate an aircraft with competence and precision, on the ground and in the air. And it means sound judgment that produces the best safety and efficiency. People often compare learning to fly with learning to drive, but that comparison is misleading. An airplane moves in three dimensions, and that demands a different kind of motor skill growth.

Four abilities will grow through your training. Coordination means using hands and feet together, without conscious thought, in the proper relationship, to produce the result you want. Timing means applying that coordination at the proper instant, so every maneuver is one constant, smooth process. Control touch means sensing what the airplane is doing, and what it is about to do, through the pressures and resistance in the flight controls. Speed sense is the ability to sense and react to reasonable changes in airspeed.

You are not learning to fly one make and model. The purpose of flight training is to build knowledge, experience, skills, and safe habits that transfer to any airplane. The goal is a safe and competent pilot. Passing the practical test for your certificate is only incidental to that goal.

Your instructor carries the full responsibility for your training. In the FAA's words, the instructor is the cornerstone of aviation safety. A good instructor uses a syllabus, a written plan of lessons. Your instructor also insists on correct techniques and procedures from the start, because proper habit formation begins on the very first training flight. The syllabus follows a building block method. Each new maneuver builds on the principles of the ones before it.

# THE STUDENT PILOT PATH: CERTIFICATES, MEDICAL, AND TESTS

**SOURCE** PHAK 25C, Ch 1, The Student Pilot + Becoming a Pilot + Pilot Certifications + Knowledge and Skill Tests

A student pilot is a person being trained by an instructor for a first full certificate. A student pilot may fly alone only under specific, limited conditions. Before you can be endorsed to fly solo, you need a Student Pilot Certificate. Your CFI usually processes it and submits it electronically through IACRA. The plastic certificate does not expire. It is required, and carried, only when you exercise solo flight privileges. To be eligible, you must be at least 16 years of age. You must also be able to read, speak, write, and understand English. There is no minimum knowledge or experience needed for the certificate itself, but there are minimums before you can solo.

The second step is the medical certificate. Medical certificates come in first, second, and third class. Third class is generally designed for the student, recreational, and private pilot. You get one by passing a physical exam from an FAA-authorized Aviation Medical Examiner. The FAA suggests getting it before you begin flight training. That way you do not pay for training you cannot continue.

You are working toward the Private Pilot Certificate. Most active pilots hold this certificate. A private pilot flies for pleasure or personal business and does not accept compensation. Passengers may still pay a pro rata share, an equal split, of expenses such as fuel or rental. Training under 14 CFR part 61 requires at least 40 hours of piloting time. That includes 20 hours of flight with an instructor and 10 hours of solo flight. The national average is about 60 to 75 hours.

Learning each flight maneuver follows four steps. The CFI introduces and demonstrates it. The CFI talks you through it. You practice it under supervision. Finally, the CFI authorizes you to practice it solo. Two tests stand between you and the certificate. The knowledge test is a computer-based, multiple-choice exam. The FAA recommends taking it after you complete a solo cross-country flight, so your real flying experience works for you. The practical test is given by an FAA inspector or, most often, a Designated Pilot Examiner. The examiner uses the Airman Certification Standards. That document defines the areas of operation, tasks, and standards you must demonstrate.

**GROUND MODULE 1B · REGULATORY FRAMEWORK**

# THE RULEBOOK: REGULATIONS, GUIDANCE, AND YOUR POH

**SOURCE** North Aero Ground Module 1B (Regulatory Framework) + 14 CFR 43.3 + 49 CFR 830.2

Five sources govern your training and your flying. Learn what each one contains, and you will know where every answer lives. The first two are regulations. Title 14 of the Code of Federal Regulations is federal law, and violating it exposes you to FAA certificate action, civil penalties, or both. 14 CFR Part 61 governs the pilot. It covers certification requirements, currency, privileges, and limitations. When you ask what your certificate lets you do, or what endorsement you need, the answer is in Part 61.

14 CFR Part 91 governs the operation of the aircraft. It contains the general operating and flight rules for all aircraft. The airworthiness rule you just learned, 91.7, lives in Part 91. So does 91.9, which requires you to operate within the airplane's approved limitations.

The next two sources are guidance, not law. The AIM gives procedural guidance that is FAA standard but not regulatory. Advisory Circulars work the same way. An AC describes an acceptable way to comply with a regulation. It is not the only acceptable way, and following it is not legally required by itself. But guidance is not something to shrug off. The AIM and the ACs show you how the FAA expects the system to work.

The fifth source is the AFM or POH for your specific airplane. It is aircraft specific, legally part of that aircraft's airworthiness, and it governs that airplane's operation. Its operating limitations bind you under 91.9, and cockpit placards carry the same regulatory weight as the AFM itself. A placard is never superseded by assumption. Only documented aircraft records, such as a formal AFM revision or a Supplemental Type Certificate, can change a limitation.

One maintenance rule deserves early awareness. Under 14 CFR 43.3(g), you may one day perform preventive maintenance on an aircraft you own or operate outside commercial rules. The tasks that qualify are listed in Part 43, Appendix A. Anything beyond that list belongs to a certificated mechanic. We will point out examples when we work on the airplane together.

One more rulebook sits outside the FAA entirely. 49 CFR Part 830 belongs to the NTSB, and it defines two words you must never confuse. An accident is an occurrence in which a person suffers death or serious injury, or the aircraft receives substantial damage. An incident is any other occurrence that affects, or could affect, the safety of operations. Accidents require immediate notification to the nearest NTSB office by the most expeditious means available. If substantial damage is confirmed, a written report on NTSB Form 6120.1 is due within ten days. Lesson 9 gives reporting its full treatment. For now, know the two definitions and know that Part 830 exists.

> *“Except for holders of a sport pilot certificate, the holder of a pilot certificate issued under part 61 may perform preventive maintenance on any aircraft owned or operated by that pilot which is not used under part 121, 129, or 135 of this chapter.”*

14 CFR 43.3(g)

> *“Incident means an occurrence other than an accident, associated with the operation of an aircraft, which affects or could affect the safety of operations.”*

49 CFR 830.2

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**GROUND MODULE 1C · STUDENT PILOT**

## CATEGORY, CLASS, AND THE PAPERS YOU CARRY

**SOURCE** North Aero Ground Module 1C (Student Pilot) + 14 CFR 1.1 + 14 CFR 61.3

Pilot certificates are organized by category, class, and sometimes type. For airmen, a category is a broad classification of aircraft. Airplane is a category. So are rotorcraft, glider, and lighter-than-air. A class is a division within a category, grouping aircraft with similar operating characteristics. Single engine, multiengine, land, and water are classes. Put them together and you get the rating you are training for: airplane category, single engine land class. A type rating names a specific make and basic model of aircraft. Type ratings are required only for certain aircraft, and our trainers are not among them.

Now the paperwork. 14 CFR 61.3 sets the rule: to exercise pilot privileges, you must have your pilot certificate in your physical possession or readily accessible in the aircraft. The same section requires a photo ID, such as a driver's license, a government ID, a passport, or a military ID. It also requires the appropriate medical certificate. You must present these for inspection when asked by the FAA, the NTSB, the TSA, or any federal, state, or local law enforcement officer. That request is called a ramp check. It is rare, professional, and painless if you know exactly where your documents are.

That is why we set the habit now. Bring four things to every lesson: your logbook, your medical certificate, your photo ID, and your student pilot certificate once it arrives. Your certificate never expires, but your medical is time limited. Know both dates.

One more piece of medical awareness. 61.3(c) lists exceptions to the medical certificate requirement. One of them lets a private pilot fly certain operations under the conditions in 61.113(i) while holding a U.S. driver's license, using the alternative medical qualification in Part 68. Pilots call this BasicMed. It is not available to you as a student working toward solo, so plan on your third class medical. But you will hear the term, and now you know where it comes from.

> *"As used with respect to the certification, ratings, privileges, and limitations of airmen, means a broad classification of aircraft. Examples include: airplane; rotorcraft; glider; and lighter-than-air"*
>
> 14 CFR 1.1, Category

> *"As used with respect to the certification, ratings, privileges, and limitations of airmen, means a classification of aircraft within a category having similar operating characteristics. Examples include: single engine; multiengine; land; water; gyroplane; helicopter; airship; and free balloon"*
>
> 14 CFR 1.1, Class

> *"A person may serve as a required pilot flight crewmember of an aircraft only if that person holds the appropriate medical certificate issued under part 67 of this chapter, or other documentation acceptable to the FAA, that is in that person's physical possession or readily accessible in the aircraft."*
>
> 14 CFR 61.3(c)(1)

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## SAFETY HABITS FROM DAY ONE: SEE AND AVOID, CLEARING, AND EXCHANGE OF CONTROLS

**SOURCE** AFH FAA-H-8083-3C, Ch 1, Safety Considerations

Certain safety practices start on the very first dual flight and never stop. The first is collision avoidance. The rules in 14 CFR part 91 set out the concept of see and avoid. The rule is vigilance at all times by each person operating an aircraft. Most midair collisions and near midair collisions occur in good VFR weather, in daylight, and within 5 miles of an airport or near navigation aids. In other words, they happen exactly where we train.

Effective scanning is a series of short, evenly spaced eye movements. Each movement covers no more than 10 degrees. Watch each area for at least 1 second. Your eyes take several seconds to refocus between the panel and distant objects. Peripheral vision, your side vision, detects movement. Movement is usually your first perception of a threat. Here is the critical cue. If another aircraft shows no relative motion but is growing in size, it is on a collision course. Immediate evasive action is required.

Before every turn and before every training maneuver, we clear the area. The point of the clearing turn is simple: be certain the next maneuver will not carry you into another aircraft's flightpath. I will teach you our clearing procedure, and I will insist on it.

Finally, there must never be any doubt about who is flying the airplane. We use a three-step exchange of controls. When I give you the airplane, I say, You have the flight controls. You acknowledge at once, I have the flight controls. I confirm, You have the flight controls. Then we make a visual check that the other person really has them. The same procedure runs in reverse when you give the airplane back. Numerous accidents have occurred because two pilots each thought the other was flying.

## CHECKLISTS: THE FOUNDATION OF STANDARDIZATION

**SOURCE** AFH FAA-H-8083-3C, Ch 1, Use of Checklists

A checklist is a memory aid. It helps ensure that the critical items for safe operation are not overlooked or forgotten. Checklists have been the foundation of pilot standardization and flight deck safety for years. They will be part of every flight you and I ever make together.

A checklist does not have to be a do list. You can perform the proper actions from flow and habit, then use the checklist to quickly confirm that every needed task was completed. The emphasis is on the check in checklist. But a checklist has no value if you are not committed to using it. Pilots who fail to take checklists seriously become complacent. They begin to rely on memory alone, and the odds then sit on the side of error.

At a minimum, use prepared checklists for these phases of flight: preflight inspection, before engine start, engine starting, before taxiing, before takeoff, after takeoff, cruise, descent, before landing, after landing, and engine shutdown and securing. A major goal of primary training is to build habit patterns that serve you for your whole flying career. Steady checklist use is one of the first.

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## PREFLIGHT ASSESSMENT: IS THIS AIRPLANE AIRWORTHY?

**SOURCE** AFH FAA-H-8083-3C, Ch 2, Preflight Assessment of the Aircraft + Visual Preflight Assessment

Before any flight, you make two determinations. First, the airplane meets its regulatory airworthiness requirements. Second, it is in a safe mechanical condition. The owner or operator is primarily responsible for maintenance. But under 14 CFR part 91, section 91.7, no person may operate a civil aircraft unless it is in an airworthy condition. The pilot in command is responsible for deciding whether the aircraft is in condition for safe flight. That duty is yours the moment you become PIC. So we build the habit now.

The paperwork check comes first. Each airplane has logbooks that record maintenance, alterations, and inspections. Inspect the logbooks, or a summary of airworthiness status, before flight. Required items include: an annual inspection within the preceding 12 calendar months; a 100-hour inspection if the aircraft is operated for hire; transponder certification within the preceding 24 calendar months; ELT inspection within the last 12 months; and compliance with airworthiness directives. Also confirm the required documents are on board or affixed. These are the airworthiness certificate, the registration certificate, operating limits in the form of the FAA-approved AFM/POH and placards, and current weight and balance data.

The visual inspection begins while you are still walking up to the airplane. Note its general appearance. Check landing gear and structure alignment. Look for distortion of the wings, fuselage, or tail. Look for skin damage, and for any staining, dripping, or puddles of fuel or oil. Inside, check that the cabin door works smoothly. Check that seat belts and harnesses are free of fraying and latch properly. Check that the seats lock into their rails. Check that the windshield is clean and free of cracks and crazing.

The exact walk-around sequence and the items to check come from the AFM/POH for our airplane. Each manufacturer sets its own sequence. Typical items include: control locks removed, master and magneto switches off, fuel selector operation, trim set for takeoff, fuel quantity gauges compared against a visual tank check, and flight instruments reading correctly with airspeed at zero. Learn the flow from the airplane's own checklist, not from a generic list.

> *"Per 14 CFR part 3, section 3.5(a), the term "airworthy" means that the aircraft conforms to its type design and is in condition for safe operation."*
>
> AFH FAA-H-8083-3C, Ch 2, Preflight Assessment of the Aircraft

# ENGINE START AND TAXI

**SOURCE** AFH FAA-H-8083-3C, Ch 2, Engine Starting + Taxiing

Engine start procedures come from the airplane's approved checklist. But some hazard controls are universal. Before start, make sure the ramp around the airplane is clear of people, equipment, and anything the propeller blast could damage. Check what is behind the airplane too. Turn the anti-collision lights on before start. Just before engaging the starter, call CLEAR out the side window. Then wait for a response from anyone nearby. Hold the brakes, and keep one hand on the throttle. That way the airplane cannot lunge forward, and you can set the initial rpm. About 1,000 rpm is generally recommended after start, to let oil pressure rise. Watch the oil pressure. In most conditions it should rise to at least the lower limit within 30 seconds. If it does not, shut the engine down immediately to prevent serious internal damage. Be alert for any sounds, vibrations, smells, or smoke that do not match normal experience.

Taxiing is the controlled movement of the airplane under its own power on the surface. Keep the airport diagram out and in view. Keep your eyes outside the airplane, scanning side to side, near and far. Carefully review your complete taxi plan. Do not expect the same instructions you got last time. If there is ever doubt about clearance from an obstruction, stop and check.

A safe taxi speed gives you positive control. It gives you time to recognize hazards. It lets you stop or turn without relying on the brakes. Taxi slow enough that movement depends on the throttle, so closing it stops the airplane promptly. Test the brakes as soon as the airplane starts moving. If braking is unsatisfactory, shut down immediately. Steer with the rudder pedals, and use brake only to tighten a turn after full pedal deflection. Slow down before turning, and keep the throttle at idle before braking rather than riding the brakes against power. Stop with the nosewheel straight.

Wind matters on the ground. With a quartering headwind, hold the upwind aileron up. Then the wind cannot lift that wing. With a quartering tailwind, hold the elevator down and the upwind aileron down. Then the wind cannot get under the tail or wing and nose the airplane over. These corrections also reduce the airplane's tendency to weathervane, to swing its nose into the wind, and they make steering easier.

# MANAGING RISK BEFORE EVERY FLIGHT: HAZARD, RISK, PAVE, AND IMSAFE

**SOURCE** PHAK 25C, Ch 2, Hazard and Risk + The PAVE Checklist + Mitigating Risk (IMSAFE)

Two definitions anchor aeronautical decision-making. A hazard is a present condition, event, or circumstance you encounter. A nick in the propeller blade is a hazard. Risk is the value you assign to the potential impact of that hazard. Different pilots see hazards differently. That is why we use structured tools instead of gut feel.

The PAVE checklist divides the risks of every flight into four categories, so nothing gets skipped: Pilot in command, Aircraft, enVironment, and External pressures. For the pilot, ask: am I ready for this trip? Think about experience, recency, currency, and physical and emotional condition. For the aircraft, ask whether it is the right airplane for the flight. Can it carry the planned load? Can it use the available runways with an adequate margin? Can it carry sufficient fuel with reserves? Once you identify the risks, decide whether they can be managed safely. If not, cancel the flight. One of the best risk controls is setting personal minimums. These are limits unique to your current experience and proficiency. Safe pilots understand the difference between what is legal under the regulations and what is smart, given their own experience.

The pilot answer inside PAVE comes from the IMSAFE checklist. It screens your physical and mental readiness. Illness: am I sick? Medication: am I taking anything that might affect judgment or make me drowsy? Stress: am I under pressure from job, money, health, or family problems? Alcohol: have I been drinking within 8 hours, or within 24 hours? Fatigue: am I tired and not adequately rested? Emotion: am I emotionally upset? Fatigue deserves special respect. It may not be apparent until serious errors are already being made.

Attitude affects the quality of your decisions. Studies have identified five hazardous attitudes that interfere with sound decision-making: anti-authority, impulsivity, invulnerability, macho, and resignation. Recognizing a hazardous thought is the first step toward neutralizing it. When you catch one, label it as hazardous. Then state the matching antidote. Memorize the antidotes so they come to mind automatically. The five attitudes and their antidotes are quoted below, exactly as the FAA tables them.

> *“The goal of risk management is to proactively identify safety-related hazards and mitigate the associated risks.”*
>
> PHAK 25C, Ch 2, Risk Management

> *“Anti-authority: “Don’t tell me.” / Follow the rules. They are usually right.”*

PHAK 25C, Ch 2, Figure 2-4, The Five Hazardous Attitudes / Antidote

> *“Impulsivity: “Do it quickly.” / Not so fast. Think first.”*

PHAK 25C, Ch 2, Figure 2-4, The Five Hazardous Attitudes / Antidote

> *“Invulnerability: “It won’t happen to me.” / It could happen to me.”*

PHAK 25C, Ch 2, Figure 2-4, The Five Hazardous Attitudes / Antidote

> *“Macho: “I can do it.” / Taking chances is foolish.”*

PHAK 25C, Ch 2, Figure 2-4, The Five Hazardous Attitudes / Antidote

> *“Resignation: “What’s the use?” / I’m not helpless. I can make a difference.”*

PHAK 25C, Ch 2, Figure 2-4, The Five Hazardous Attitudes / Antidote

**LESSON 1 · INTRODUCTION TO FLIGHT**

# *REVIEW QUESTIONS*

*Answer in writing before your preflight briefing. Key at the back of this volume.*

1. Who decides whether the airplane is in condition for safe flight before you go fly?
2. What does the term airworthy mean?
3. Describe the three-step exchange of flight controls.
4. Name the five hazardous attitudes, and give the antidote for invulnerability.
5. What does each letter of PAVE stand for, and what is the checklist used for?
6. Run the IMSAFE checklist from memory.
7. What is a safe taxi speed?
8. After engine start, what do you watch first, and what do you do if it is wrong?
9. When are you required to have your Student Pilot Certificate with you?
10. Describe the visual scanning technique for collision avoidance, and the cue that another aircraft is on a collision course.
11. What happens if you violate a regulation, versus choosing not to follow an Advisory Circular?
12. What legal weight do the POH/AFM and its cockpit placards carry?
13. Under 49 CFR Part 830, what is the difference between an accident and an incident?
14. May a private pilot legally perform any maintenance on an airplane?
15. Explain category and class as they apply to pilot certification.
16. Which documents must you have to exercise pilot privileges, and who may inspect them?

**LESSON 2** · **PAIRS WITH GROUND MODULE 2**

# *Basic Maneuvers: Slow Flight, Stalls, Steep Turns Intro*

*On this flight you take over more of the work: preflight planning, the walk-around, engine start, radios, and taxi. In the air we introduce the maneuvers that matter most before solo. Those are slow flight, power-off stalls, and a demonstration of steep turns. This chapter gives you the four fundamentals that every maneuver is built from. It covers the aerodynamics behind lift and the stall. It covers the technique and common errors for slow flight and stall recovery. And it covers the radio phraseology you will start using on every flight.*

**MEMORY AID** · **FAA**

### Stall Recovery Flow

*The four-step recovery you fly at the first sign of a stall, in this order every time.*

1. Push: reduce the angle of attack with nose-down pitch until the stall warning is eliminated.
2. Roll: level the wings, using rudder to cancel yaw.
3. Power: add power as needed.
4. Return: fly back to the desired flightpath, and do not pull into a secondary stall.

AFH FAA-H-8083-3C, Ch 5, Fundamentals of Stall Recovery

## RADIO COMMUNICATIONS: TECHNIQUE AND PHRASEOLOGY

**SOURCE** AIM, Ch 4, Section 2, Radio Communications Phraseology and Techniques

Radio communications are a critical link in the ATC system. Brevity matters, but controllers must know what you want before they can do their job. Acknowledge each communication with your call sign. Jargon, chatter, and CB slang have no place on the radio, and good phraseology, standard radio wording, is the mark of a professional pilot.

Two habits fix most beginner radio problems. First, listen before you transmit. If you key the mike while someone else is talking, you jam their transmission, and everyone repeats themselves. Second, think before keying. Know what you want to say, and if it is lengthy, jot it down. Hold the microphone close to your lips, pause briefly after keying so the first word transmits, and speak in a normal, conversational tone.

Initial contact follows a format: the facility you are calling, your full aircraft identification, your position when on the airport surface, and your request if it is short. For example: Columbia Ground, Cessna Three One Six Zero Foxtrot, south ramp, I-F-R Memphis. State the aircraft type or manufacturer with the registration number, dropping the N prefix. Never abbreviate your call sign on initial contact. Once ATC shortens it to the prefix and last three characters, you may too.

Use the ICAO phonetic alphabet for letters, and speak numbers digit by digit in most cases: 122.1 is one two two point one, and 12,500 is one two thousand five hundred. Call ground stations by facility name and type: Shannon UNICOM, Augusta Tower, Miami Ground.

One more tool was built just for you: identify yourself as a student pilot on initial contact. For example: Dayton tower, Fleetwing One Two Three Four, student pilot. This alerts controllers to give you extra assistance and consideration. The FAA recommends it on initial contact with each facility.

> *"The single, most important thought in pilot-controller communications is understanding."*

AIM, Para 4-2-1, General

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## THE FOUR FUNDAMENTALS AND HOW THE CONTROLS FEEL

**SOURCE** AFH 3C, Ch 3 (via verified summary; see gaps)

An airplane rotates in bank, pitch, and yaw, and it also moves horizontally, vertically, and laterally. The four fundamentals are straight and level flight, turns, climbs, and descents. They are the principal maneuvers that control the airplane through those six motions of flight. Every maneuver you will ever fly is built from these four. A weakness here becomes a barrier to everything that follows.

You fly with pressures, not movements. Airflow over the control surfaces resists your inputs, and that resistance grows as airspeed increases and fades as it decreases. Hold the yoke lightly with your fingers. A common beginner error is squeezing with a closed palm until the sensitive feel is lost. On the rudder pedals, press smoothly with the ball of each foot, with your heels resting on the floor.

The airplane also talks to you through sound and vibration. Listen to the airflow over the airframe and the engine and propeller notes, and feel the accelerations in your seat. That sensory feel takes time, and it never replaces your eyes. But we start building it now.

# STRAIGHT AND LEVEL, TURNS, CLIMBS, AND GLIDES: A FIRST LOOK

**SOURCE** AFH 3C, Ch 3 (via verified summary; see gaps)

Straight and level flight is flight in which heading and altitude are constantly maintained. Fix a reference point on the airplane against the natural horizon, and check that both wingtips sit level and equally above or below it. The goal is catching small deviations early, so only small corrections are needed.

A turn begins by banking the wings in the desired direction. Banking divides lift into vertical and horizontal components, and the horizontal component pulls the airplane toward the bank. Add slight back pressure to hold altitude. The rudder does not turn the airplane; it cancels adverse yaw so the turn stays coordinated.

In a climb, the climb rate is limited by excess thrust. Best rate of climb, Vy, gains the most altitude in a given time. Best angle of climb, Vx, gains the most altitude in a given distance, and it is used to clear obstacles. Expect right rudder at climb power. A partial power descent at constant airspeed is the normal method of losing altitude.

A glide is a controlled descent with little or no engine power. Best glide speed gives the greatest forward distance for the altitude lost. Any faster or slower increases drag and shortens the glide. Never try to stretch a glide with back pressure below best glide speed. The airplane lands short, and a stall and loss of control are possible.

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# THE FOUR FORCES OF FLIGHT

**SOURCE** PHAK 25C, Ch 5, Forces Acting on the Aircraft

Four forces act on the airplane in flight. Thrust is the forward force produced by the powerplant and propeller; it opposes or overcomes drag, and as a general rule it acts parallel to the longitudinal axis. Drag is a rearward, slowing force caused by disruption of airflow by the wing, fuselage, and protruding objects. It opposes thrust and acts rearward, parallel to the relative wind. Lift is produced by the dynamic effect of air acting on the airfoil, and it acts perpendicular to the flightpath through the center of lift. Weight is the combined load of the airplane, crew, fuel, and baggage, and it pulls downward through the center of gravity.

In steady flight, the sum of these opposing forces is always zero. Lift and weight are equal to each other, and they are larger than thrust and drag, which are equal only to each other. When the flightpath is not horizontal, each force breaks into components. In a climb, part of thrust acts upward like lift, and in a glide, part of weight acts along the flightpath like thrust.

Here is one more definition you will use every lesson from now on. Angle of attack, or AOA, is the acute angle between the chord line of the airfoil and the direction of the relative wind. AOA is fundamental to performance, stability, and control. It is the heart of today's stall work.

# HOW THE WING MAKES LIFT

**SOURCE** PHAK 25C, Ch 4, Principles of Flight (whole chapter)

Air is a fluid. It has mass and weight, it flows, and it resists flow slightly through viscosity and friction. Air flowing over a wing clings to the surface in a thin boundary layer, and that combined resistance is drag. The standard atmosphere at sea level is 59 degrees F (15 degrees C) and 29.92 inches of mercury. Both pressure and temperature fall as you climb, so air density decreases with altitude.

Density altitude is pressure altitude corrected for nonstandard temperature. It describes what the airplane feels. As air becomes less dense, the engine takes in less air, the propeller gets less efficient, and the thin air exerts less force on the airfoils, so power, thrust, and lift all decrease. High elevations, low pressure, high temperature, and high humidity all raise density altitude and cut performance. No matter its actual altitude, the airplane performs as though it were at the existing density altitude.

Lift itself rests on Newton's laws and Bernoulli's principle. Newton's third law says every action has an equal and opposite reaction. The airfoil forces air downward, and the air forces the airfoil upward. Bernoulli's principle says that as the velocity of a moving fluid increases, the pressure within the fluid decreases. Air moving faster over the curved upper surface of the wing creates a low pressure area above it. Both are at work whenever an airfoil makes lift, and the pressure difference alone does not account for the total lift force.

An airfoil is a structure designed to obtain a reaction from the air through which it moves. The chord line runs straight from the leading edge to the trailing edge. As airflow meets the wing at different angles of attack, regions of negative pressure form above and positive pressure below. The average of that pressure variation for a given AOA is the center of pressure, and it moves forward at high AOA and aft at low AOA. At the wingtip, high pressure air from below spills around the tip into the low pressure above. That creates a tip vortex and downwash, which reduce lift, and this is why some airplanes wear winglets.

**GROUND MODULE 2 · AERODYNAMICS AND SPIN AWARENESS**

# THE LIFT EQUATION IN PLAIN WORDS

**SOURCE** North Aero Ground Module 2 (Aerodynamics and Spin Awareness) + PHAK 25C, Ch 5, Lift

Lift can be written as an equation, and the equation is worth understanding in plain language. Lift equals the coefficient of lift, times air density, times velocity squared, times wing area, divided by two. The coefficient of lift comes from the shape of the wing and its angle of attack. Air density describes how thick the atmosphere is, and velocity is how fast the wing travels through it. Wing area is fixed by the manufacturer, and the density is whatever the day delivers. That leaves exactly two levers under your control in flight: angle of attack and airspeed.

Notice that velocity is squared, which means airspeed multiplies lift rather than merely adding to it. Double your airspeed at a constant angle of attack, and the wing produces four times the lift. That relationship is why small speed changes matter so much near the runway, and why extra knots on final approach will float you far down the pavement.

The two levers trade against each other continuously. When you hold altitude and accelerate, you must reduce the angle of attack by lowering the nose, or the airplane climbs. When you hold altitude and decelerate, you must increase the angle of attack to keep lift equal to weight. In steady level flight, every angle of attack therefore has one matching airspeed. The slow end carries a limit, because raising the AOA past the critical angle stalls the wing. You felt exactly this trade during today's slow flight work.

Density is the lever the atmosphere controls, and lift varies directly with it. Warm air is less dense than cool air, and moist air is less dense than dry air. At 18,000 feet the air carries only half of its sea level density. At altitude, or on a hot and humid afternoon, the airplane must fly at a greater true airspeed to produce the same lift at a given angle of attack. That is the lift equation working behind the density altitude discussion you just read.

> *“Lift is proportional to the square of the aircraft’s velocity. For example, an airplane traveling at 200 knots has four times the lift as the same airplane traveling at 100 knots, if the AOA and other factors remain constant.”*
>
> PHAK 25C, Ch 5, Lift

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**GROUND MODULE 2 · AERODYNAMICS AND SPIN AWARENESS**

# THE V-SPEEDS AND WHERE THEY LIVE ON THE AIRSPEED INDICATOR

**SOURCE** North Aero Ground Module 2 (Aerodynamics and Spin Awareness) + 14 CFR 1.2 + PHAK 25C, Ch 8, Airspeed Indicator Markings

Every limitation speed carries a V name, and most of them are painted on the airspeed indicator in color. FAA certificated aircraft of 12,500 pounds or less, manufactured after 1945, must carry these standard color coded markings. The colors let you recognize a limitation at a glance in the middle of a maneuver. The numbers themselves belong to your specific airplane, so learn them from the POH.

Begin with the white arc, which marks the flap operating range. Its lower limit is VS0, the stalling speed or minimum steady flight speed in the landing configuration, with gear and flaps down. Its upper limit is VFE, the maximum speed permitted with the flaps extended. Approaches and landings are usually flown at speeds inside the white arc.

The green arc is the normal operating range, where most of your flying happens. Its lower limit is VS1, the stalling speed or minimum steady flight speed in a specified configuration, usually clean. Its upper limit is VNO, the maximum structural cruising speed, which you do not exceed except in smooth air. Above the green arc sits the yellow caution range, flown only in smooth air and only with caution. The red line marks VNE, the never exceed speed, and operating beyond it invites damage or structural failure.

One critical speed is not painted anywhere on the dial: VA, the design maneuvering speed. VA is the maximum speed at which the structural design's limit load can be imposed, by gusts or by full deflection of a control surface, without causing structural damage. You find it on placards and in the AFM/POH, and it changes with aircraft weight. Here is the reason. At the same airspeed, a lighter airplane flies at a lower angle of attack, which leaves more room to pull additional G before reaching the critical angle and stalling. More available G means the structure can be overstressed at a lower speed. When the airplane is light, VA comes down, and your speed in rough air should come down with it.

Two more V speeds complete your set, and you already met them in the climb discussion: VX, the speed for best angle of climb, and VY, the speed for best rate of climb. Neither one appears on the dial, and both come from the POH. Memorize your airplane's numbers early, because VX and VY shape every takeoff and VS0 thinking shapes every landing.

> *"VS0 means the stalling speed or the minimum steady flight speed in the landing configuration."*

14 CFR 1.2

> *"It is important to consider weight when referencing this speed. For example, VA may be 100 knots when an airplane is heavily loaded, but only 90 knots when the load is light."*

PHAK 25C, Ch 8, Other Airspeed Limitations

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## SLOW FLIGHT

**SOURCE** AFH FAA-H-8083-3C, Ch 5, Slow Flight + Performing the Slow Flight Maneuver + Maneuvering in Slow Flight

Flying at reduced airspeed is normal in takeoff, departure, approach, and landing. Slow flight training exists so you learn the feel, sound, and visual cues of that regime at a safe altitude. In that regime, control response is degraded, and holding altitude takes more attention. For training and testing, target an airspeed at which the airplane can still maneuver without setting off the stall warning, about 5 to 10 knots above the 1G stall speed. Practice it in configurations that fit takeoffs, climbs, descents, approaches, and go-arounds. Slow flight in a single-engine airplane should be completed no lower than 1,500 feet AGL.

To enter, clear the area, gradually reduce power, and adjust pitch to let airspeed decrease while holding altitude. As speed approaches the target, additional power is needed to hold altitude. Trim as the pressures change. An airplane still trimmed for cruise demands strong aft pressure, and that makes precise control difficult. Slow flight is typically performed and evaluated in the landing configuration: gear and flaps down, with the before-landing checks complete.

Expect the controls to feel different. As airspeed decreases, control effectiveness decreases, and larger movements are needed for the same response. Pilots call it sloppy or mushy. Below the minimum drag speed, you are on the backside of the power curve. There, pitch becomes a more effective control of airspeed, and power controls the flightpath. The airplane also shows speed instability: if disturbed, the airspeed keeps decaying unless you reduce AOA or add power. Torque, slipstream effect, and P-factor produce a strong left yaw at high power and low speed. So hold right rudder, and more of it the closer you get to the stall.

To exit, add power, apply forward pressure as airspeed and lift increase, maintain coordination, and return to the desired flightpath, cleaning up flaps and gear as airspeed allows. Common errors include: failure to clear the area; inadequate or excessive back pressure as power is reduced; insufficient right rudder; fixation on the instruments; failure to anticipate AOA changes as the flaps move; poor trim; and failure to respond to a stall warning.

## THE STALL: DEFINITION AND RECOGNITION

**SOURCE** AFH FAA-H-8083-3C, Ch 5, Angle of Attack + Stalls + Stall Recognition + PHAK 25C, Ch 5, Stalls

A stall happens when the wing's angle of attack exceeds its critical AOA. Past that angle, the smooth airflow over the upper surface separates, lift decreases sharply, and drag rises. The wing does not totally stop producing lift in a stall; it simply cannot make enough lift to sustain level flight. The critical AOA is a design characteristic. For a given configuration, the airplane always stalls at the same AOA, regardless of airspeed, weight, load factor, or density altitude.

Burn this in: a stall is about angle, not speed. The published stalling speed is valid only in unaccelerated 1G flight, coordinated, at one weight, and at a particular CG. Increase load factor, and stall speed rises. Pull sharply out of a dive at 100 knots, and the AOA can jump past critical despite the high airspeed.

We practice stalls at two levels. An impending stall occurs when the AOA causes a stall warning but has not yet reached the critical AOA. Signs can include buffeting or an aural warning. A full stall occurs when the critical AOA is exceeded. The typical sign is an uncommanded nose-down pitch that cannot be readily arrested, possibly with an uncommanded rolling motion.

Learn to recognize an approaching stall by sight, sound, and feel. Control pressures lighten, and responses slow. The sound of the airflow changes as speed decays. The seat-of-the-pants sense of changing direction or speed warns the trained pilot. Vision alone is not foolproof, since the airplane can stall in any attitude. Most training airplanes add a stall warning device that alerts you before the critical AOA. In most straight-wing airplanes, the wing root stalls first, which preserves aileron effectiveness at the tips as the stall spreads outward.

> *“An aircraft stall results from a rapid decrease in lift caused by the separation of airflow from the wing’s surface brought on by exceeding the critical AOA. A stall can occur at any pitch attitude or airspeed.”*
>
> PHAK 25C, Ch 5, Stalls

> *“It is important for the pilot to understand that a stall is the result of exceeding the critical AOA, not of insufficient airspeed.”*
>
> AFH FAA-H-8083-3C, Ch 5, Angle of Attack

> *"This critical AOA varies from approximately 16° to 20° depending on the aircraft's design. But each aircraft has only one specific AOA where the stall occurs."*

PHAK 25C, Ch 5, Stalls

# STALL RECOVERY AND THE POWER-OFF STALL

> **SOURCE** AFH FAA-H-8083-3C, Ch 5, Fundamentals of Stall Recovery + Full Stalls, Power-Off

The full stall recovery template has as many as six steps, but in our trainer it reduces to four. Reduce the AOA with nose-down pitch control until the stall warning is eliminated. Roll the wings level, add power as needed, and then return to the desired flightpath while avoiding a secondary stall. Reduce AOA first. In numerous cases, pilots put power and holding altitude ahead of reducing AOA, and the result was loss of control. Rolling the wings level orients the lift vector for recovery. But do not chase bank angle before the AOA is reduced; roll control improves dramatically once the wing is flying again. Use rudder to cancel yaw, so a stall cannot progress into a spin.

Some loss of altitude is expected in any recovery. The longer you take to recognize an impending stall, the more likely a full stall becomes. That is why we practice at altitude. Practice stalls so the recovery is completed no lower than 1,500 feet AGL for single-engine airplanes.

The power-off stall simulates an accidental stall on approach to landing. Set up in the landing configuration, hold altitude while airspeed decays to normal approach speed, and then establish a stabilized descent at idle power. Smoothly raise the nose to an attitude that induces the stall. Keep the wings level and the airplane coordinated, and hold that attitude until the stall occurs. Recover with as much nose-down input as needed to eliminate the stall warning. Level the wings, stay coordinated, and add power. Expect right rudder as the power comes in. If you are simulating a stall on approach, finish with a go-around: get a positive rate of climb, then retract flaps and gear as appropriate.

We will also practice power-off stalls from shallow banked turns, which simulate the turn from base to final. Keep the airplane coordinated at a constant bank until the stall. If it slips or skids, one wing may drop first. The recovery procedure is exactly the same no matter which wing rolls off.

> *"Even so, the pilot should remember the most important action to an impending stall or a full stall is to reduce the AOA."*
>
> AFH FAA-H-8083-3C, Ch 5, Fundamentals of Stall Recovery

> *"Adding power typically reduces the loss of altitude during a stall recovery, but it does not eliminate a stall. The reduction in AOA is imperative."*
>
> AFH FAA-H-8083-3C, Ch 5, Fundamentals of Stall Recovery

# ANGLE OF ATTACK INDICATORS

**SOURCE** PHAK 25C, Ch 5, Angle of Attack Indicators + AFH FAA-H-8083-3C, Ch 5, Stall Recognition

An AOA indicator gives you stall margin awareness: the margin between the AOA you are flying and the critical AOA where the wing stalls. The FAA promotes AOA indicators as a safety initiative aimed at loss of control, the number one root cause of fatal accidents in aviation. Half of fatal maneuvering accidents involve stall or spin scenarios.

The case for the instrument is the weakness of airspeed as a stall predictor. Speed by itself is not a reliable parameter to avoid a stall; an airplane can stall at any speed. Angle of attack is the better parameter. For a given configuration, the airplane always stalls at the same critical AOA, and that critical AOA does not change with weight, bank angle, temperature, density altitude, or center of gravity.

These devices measure several parameters at the same time, and they display the current AOA and how close it is to the critical AOA. If your airplane has one, learn how the device determines AOA and what its display means. Some indicators account for flap position, and some do not. The indicator supplements the stall cues you are learning by feel, sight, and sound. It never replaces them.

# TURNS, LOAD FACTOR, AND YOUR FIRST LOOK AT STEEP TURNS

**SOURCE** PHAK 25C, Ch 5, Stalls (load factor in turns) + AFH FAA-H-8083-3C, Ch 5, Angle of Attack

Today I will demonstrate steep turns. The aerodynamics you just learned explain why they deserve respect. In a level turn, the wing must produce additional lift to counterbalance the load from the combination of centrifugal force and weight. You get the additional lift with elevator back pressure, which increases the AOA. The steeper the bank, the more the AOA must increase to carry the growing load.

That load has a number: load factor. Say a pilot holds airspeed and rolls into a coordinated, level 60 degree banked turn. The load factor is 2G, and the airplane will stall at a speed 41 percent higher than its 1G stall speed. Stalling speed rises in a turn because you are closer to the critical AOA while carrying more than 1G.

A steep turn is a division-of-attention exercise. You manage bank, back pressure, power, altitude, and orientation all at once, with a reduced stall margin. If at any time the AOA becomes excessive, the airplane stalls, regardless of indicated airspeed. Watch the demonstration with that in mind, because you will be flying these yourself soon.

**LESSON 2 · BASIC MANEUVERS: SLOW FLIGHT, STALLS, STEEP TURNS INTRO**

# *REVIEW QUESTIONS*

*Answer in writing before your preflight briefing. Key at the back of this volume.*

1. What causes a stall?
2. What is the critical AOA for most airplanes, and does it change with weight or altitude?
3. What is the first and most important action in any stall recovery?
4. Why does adding power alone not recover a stall?
5. What airspeed do we target for slow flight, and what is the minimum recovery altitude for practicing it?
6. Why do you need right rudder in slow flight at high power?
7. In a level, coordinated 60 degree bank turn, what are the load factor and the effect on stall speed?
8. What are the elements of an initial radio call to a ground station?
9. How can you get extra help from ATC as a student?
10. What are the four fundamentals?
11. Why must you never try to stretch a glide?
12. Under what conditions is the published 1G stall speed valid?
13. Name the four factors in the lift equation, and the two you control directly in flight.
14. You double your airspeed while holding the same AOA. What happens to lift?
15. Walk through the airspeed indicator markings: what are the limits of the white and green arcs, and what do the yellow arc and red line mean?
16. Which important limit speed is not color coded on the airspeed indicator, and where do you find it?
17. Does VA increase or decrease as the airplane gets lighter, and why?

**LESSON 3** · **PAIRS WITH GROUND MODULE 3**

# *Four Fundamentals and Coordination*

*From this lesson forward, the preflight, engine start, radios, taxi, and parking are yours without direction. In the air we work toward reasonable proficiency in the four basic flight maneuvers and clean coordination. That includes slow flight, power-off stalls, and the Dutch roll coordination exercise. This chapter gives you the energy management framework that ties altitude and airspeed control together. It gives you the attitude flying method and the lead point rules that make the four fundamentals precise. It also gives you a full tour of the flight controls, and the aerodynamic reasons your feet have work to do.*

**MEMORY AID** · **NORTH AERO TEACHING AID**

## Pitch, Power, Trim

*The order of operations for every level-off and profile change: set the attitude, set the power, then remove the pressure.*

Pitch: set the new attitude against the natural horizon and hold it with pressure.

Power: set the power the new profile requires.

Trim: trim away the remaining pressure so the airplane holds the attitude on its own.

North Aero teaching flow, grounded in AFH 3C, Ch 3 (attitude flying and level-off procedure)

**MEMORY AID** · **FAA**

## Left-Turning Tendencies

*The four forces that pull the nose left at high power and high angle of attack, and the reason your right foot has work to do.*

Torque reaction: the engine turns the propeller one way, so an equal force rolls the airplane the other way.

Spiraling slipstream: the corkscrew of propeller air strikes the vertical tail and yaws the nose left.

Gyroscopic precession: a force applied to the spinning propeller acts 90 degrees later, so pitching produces yaw.

P-factor: at high angle of attack the descending blade takes a bigger bite of air, shifting thrust right of center and yawing the nose left.

PHAK 25C, Ch 5, Torque and P-Factor

## THE AIRPLANE AS AN ENERGY SYSTEM

**SOURCE** AFH FAA-H-8083-3C, Ch 4, Introduction + Viewing the Airplane as an Energy System

Every maneuver you fly is an energy problem. Energy management means planning, monitoring, and controlling your altitude and airspeed targets in relation to the airplane's energy state. The goals are simple. Reach and hold the vertical flightpath and airspeed profiles you want. Detect and correct unintentional deviations. And prevent an irreversible deceleration or sink rate that ends in a crash. Mismanaged energy contributes to the three most common types of fatal accidents: loss of control in flight, controlled flight into terrain, and approach-and-landing accidents.

The airplane's total mechanical energy is the sum of two parts. Potential energy comes from altitude, and kinetic energy comes from airspeed. The airplane gains energy from engine thrust and loses energy to aerodynamic drag. When thrust exceeds drag, total energy increases, and you can store the surplus as altitude, as airspeed, or as some of each. When drag exceeds thrust, total energy decreases, and you spend stored energy: descend at constant airspeed, or slow down at constant altitude. When thrust equals drag, total energy holds steady. But you can still exchange energy between altitude and airspeed, trading one for the other in opposite directions.

Your frame of reference is the airplane itself: indicated altitude and indicated airspeed, not height above the ground or groundspeed. Terrain and wind are outside factors you cannot alter. But you manage the airplane's energy to minimize the risks they pose.

## WHAT THE THROTTLE CONTROLS, WHAT THE ELEVATOR CONTROLS

**SOURCE** AFH FAA-H-8083-3C, Ch 4, Role of the Controls to Manage Energy State

An energy view clears up the old argument about pitch versus power. Do not ask what controls altitude and what controls airspeed. Ask what controls total energy, and what controls its distribution. The throttle sets thrust against drag, so it regulates changes in total mechanical energy. The elevator adjusts pitch attitude, so it allocates changes in total energy between vertical flightpath and airspeed.

Neither control commands altitude or airspeed by itself, because those two variables are coupled through the airplane's total energy. You coordinate both controls to manage the energy state. Think of the reservoir analogy. The throttle is the valve that regulates net energy flow into the airplane. The elevator is the valve that distributes that flow between the altitude reservoir and the airspeed reservoir.

The elevator has one more role at the edges of the envelope. Picture the backside of the power curve: low speed, high AOA, and little or no excess power. Pushing forward briefly trades altitude for airspeed. That reduces induced drag and frees up excess power, so the airplane can climb again. That counterintuitive push is central to recovering from a deteriorating low-and-slow situation. It echoes exactly what you learned about stall recovery: reduce the AOA first.

> *“The throttle then is the total energy controller.”*
>
> AFH FAA-H-8083-3C, Ch 4, Primary Energy Role of the Throttle and Elevator

> *“Thus, the elevator is the energy distribution controller.”*
>
> AFH FAA-H-8083-3C, Ch 4, Primary Energy Role of the Throttle and Elevator

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## THE THREE BASIC RULES OF ENERGY CONTROL

**SOURCE** AFH FAA-H-8083-3C, Ch 4, Three Basic Rules of Energy Control

Every transition you will fly this lesson is one of three cases. Entering a climb, leveling off, starting a descent, changing speed in level flight: the new energy state demands more total energy, less total energy, or the same total energy redistributed. The FAA's three rules are quoted exactly below. They tell you what the throttle does and what the elevator does in each case. Read them slowly, and picture the maneuver each one describes.

Map them to today's flight. Climb at constant airspeed: rule 1, throttle up, and pitch up just enough to hold the speed. Accelerate in level flight: rule 1 again, throttle up, with gradual pitch down to hold altitude. Descend at constant airspeed: rule 2, throttle back, and pitch down just enough to hold speed. Slow down in level flight, as when entering slow flight: rule 2, throttle back, with gradual pitch up to hold altitude. In every case, once you reach the new target, readjust pitch and power to maintain the new profile, and trim off the pressures.

The rules can also combine. At maximum level cruise speed, there is no excess thrust left to climb with. So you first trade speed for altitude under rule 3, slowing to a speed where drag falls below thrust. Then you climb at that slower speed under rule 1.

> *“Rule #1: If you want to move to a new energy state that demands more total energy, then: Throttle: increase throttle setting so that thrust is greater than drag, thus increasing total energy; Elevator: adjust pitch attitude as appropriate to distribute the total energy being gained over altitude and airspeed: a. To climb at constant speed, pitch up just enough to maintain the desired speed; b. To accelerate at constant altitude, gradually pitch down just enough to maintain path.”*
>
> AFH FAA-H-8083-3C, Ch 4, Three Basic Rules of Energy Control

> *“Rule #2: If you want to move to a new energy state that demands less total energy, then: Throttle: reduce throttle setting so that thrust is less*

> *than drag, thus decreasing total energy; Elevator: adjust pitch attitude as appropriate to distribute the total energy being lost over altitude and airspeed: a. To descend at constant speed, pitch down just enough to maintain the desired speed; b. To slow down at constant altitude, gradually pitch up just enough to maintain path.”*

AFH FAA-H-8083-3C, Ch 4, Three Basic Rules of Energy Control

> *“Rule #3: If you want to move to a new energy state that demands no change in total energy, then: Throttle: do not change initially, but adjust to match drag at the end of maneuver as needed to maintain total energy constant; Elevator: adjust pitch attitude to exchange energy between altitude and airspeed: a. To trade speed for altitude, pitch up; b. To trade altitude for speed, pitch down.”*

AFH FAA-H-8083-3C, Ch 4, Three Basic Rules of Energy Control

# RECOGNIZING AND CORRECTING ENERGY ERRORS

**SOURCE** AFH FAA-H-8083-3C, Ch 4, Managing Energy Errors + Preventing Irreversible Deceleration and/or Sink Rate

Altitude and airspeed store the airplane's energy. So deviations from your targets are energy errors, and there are two kinds. In a total energy error, the airplane has too much or too little energy overall. Altitude and airspeed deviate in the same direction: higher and faster, or lower and slower. Correct total energy errors with the throttle. In an energy distribution error, the total is right but the split is wrong. Altitude and airspeed deviate in opposite directions: higher and slower, or lower and faster. Correct distribution errors by exchanging energy with the elevator. A combined error, such as low but on speed, takes both controls at once: throttle forward, while easing aft to regain altitude without losing airspeed.

Monitor the altimeter and airspeed indicator together. That is how you tell the two kinds apart, and it is why I will keep asking you for both numbers, not just one. Once the deviation is corrected, retrim for the desired profile.

This matters because of the trap at the slow edge of the envelope. Badly mismanage energy and get very slow, and induced drag can rise so high that even full throttle yields no surplus energy. The only recourse is to first trade altitude for speed by pushing forward, which reduces AOA and induced drag. Only then will full throttle produce a climb. Get too low, and there may not be room to reverse the sink. Unintended energy depletion shows up in unstable slow approaches, high-drag go-arounds, and steeper-than-normal turns in the pattern. So the habit of monitoring and correcting energy errors early is a survival skill, not a technicality.

GROUND MODULE 3 · SYSTEMS 1: POWERPLANT AND FUEL

# YOUR ENGINE: THE FOUR-STROKE CYCLE AND DUAL IGNITION

**SOURCE** North Aero Ground Module 3 (Systems 1) + PHAK 25C, Ch 7, Reciprocating Engines and Ignition System

Starting this lesson, the engine start and runup are yours. So you need to know what the engine is doing. Your trainer uses a spark ignition, four-stroke reciprocating engine. Each cylinder repeats the same four strokes. Intake: the piston moves down, the intake valve opens, and fuel-air mixture is drawn into the cylinder. Compression: the valve closes and the piston squeezes the mixture toward the top. Power: the spark plugs ignite the mixture, and the pressure drives the piston back down. That push is what turns the crankshaft and the propeller. Exhaust: the exhaust valve opens and the piston pushes the burned gases out. Even at fairly low speed, this cycle happens several hundred times each minute. In a four-cylinder engine, each cylinder is on a different stroke, so the power flows continuously.

The spark comes from two magnetos, not from the battery. A magneto generates its own current with a permanent magnet, and it fires whenever the crankshaft is turning. Each magneto fires its own spark plug in each cylinder, so every cylinder has two plugs. Two flames improve combustion and give slightly more power. If one magneto fails, the other is unaffected, and the engine keeps running with only a slight power loss.

The runup check proves both magnetos are alive. From BOTH, you switch to one magneto and watch the tachometer. A small RPM drop is normal, because one flame burns the mixture less completely than two. North Aero teaches the typical limits: an acceptable drop is 125 RPM or less, with a maximum spread of 50 RPM between the two magnetos. The POH's published limits govern your airplane. So a 75 RPM drop is healthy. A 200 RPM drop is not. It can mean a fouled spark plug, a faulty magneto, improper timing, or a defective ignition lead. Return the switch to BOTH, taxi back, and have a mechanic inspect it before flight. That is a no-go. One more trap: no drop at all is also abnormal, and the airplane should not be flown.

The magnetos' independence has a dark side. After shutdown, turn the ignition switch OFF before anyone leaves the airplane. Pulling the mixture to cutoff starves the engine of fuel, but it does not ground the magnetos. If the switch is left on and someone moves the propeller, a cylinder with residual fuel can fire. A broken ground wire can create the same hazard even with the switch OFF. Treat every propeller as live.

> *"A magneto uses a permanent magnet to generate an electrical current completely independent of the aircraft's electrical system."*
>
> PHAK 25C, Ch 7, Ignition System

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GROUND MODULE 3 · SYSTEMS 1: POWERPLANT AND FUEL

# FUEL: 100LL, CONTAMINATION, AND WHY YOU SUMP

**SOURCE** North Aero Ground Module 3 (Systems 1) + PHAK 25C, Ch 7, Fuel Grades and Fuel Contamination

Your trainer burns aviation gasoline, and the standard grade today is 100LL, dyed blue. The grade number reflects octane: the fuel's resistance to detonating under pressure. The correct grade is stated in the POH, on flight deck placards, and next to the filler caps. If the proper grade is not available, use the next higher grade. Never use a lower one. A lower grade can push cylinder head and oil temperatures past their limits and cause detonation. Never use automotive gas unless the airplane carries an STC for it.

Water is the principal fuel contaminant. In cold weather it can freeze and block the fuel lines. In warm weather it can flow into the carburetor and stop the engine. That is why you sump. Before every flight, drain fuel from each tank sump and from the fuel strainer quick drain into a transparent tester. Check it for water and dirt. Water shows as a clear blob under the blue fuel, or as a cloudy look when droplets are suspended. If you find any, keep draining samples until no trace appears. Filling the tanks after the last flight of the day keeps moist air out of the tanks and prevents condensation.

Now the hard lesson. In October 2021, a student pilot died at Ukiah, California when water reached his engine during a go-around (NTSB WPR22FA022). He had sumped correctly that morning. So had the pilot who flew before him. Both found fuel that appeared normal. A buckled skin inside the left tank had trapped water above the drain port, where no sump could reach it. A longstanding filler neck leak had let rain in all week. The lesson: sumping is necessary but not sufficient. When an airplane has sat outside through heavy rain, take a larger sample. Check the filler neck area for staining that suggests a leak. If anything in the fuel system's history troubles you, involve a mechanic before you fly.

> *"Never take off until all water and contaminants have been removed from the engine fuel system."*
>
> PHAK 25C, Ch 7, Fuel Systems

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GROUND MODULE 3 · SYSTEMS 1: POWERPLANT AND FUEL

# CARBURETOR ICE, MIXTURE, COOLING, AND OIL

> **SOURCE** North Aero Ground Module 3 (Systems 1) + PHAK 25C, Ch 7, Carburetor Icing, Mixture Control, and Oil Systems

Carburetor ice is the quiet engine killer, and it does not need a cold day. Inside the carburetor, fuel evaporates and air accelerates through the venturi. Both effects drop the temperature sharply, by as much as 70 degrees Fahrenheit. Moisture in the air can then freeze inside the throat and choke off the mixture. Ice is most likely when the temperature is below 70 degrees Fahrenheit and the relative humidity is above 80 percent. The FAA icing probability chart shows serious icing at glide power from 20 to 70 degrees when humidity is above 80 percent. That describes an ordinary Salinas morning. The risk is greatest at low power, in descents and while idling on the ground. At low power the engine makes little heat while the venturi keeps cooling.

In our fixed-pitch trainers, the first sign is an RPM drop you did not command. Engine roughness may follow. The response is full carburetor heat, immediately, and hold it. The engine will likely run rougher at first. That is melted ice passing through as water, and it can last from 30 seconds to several minutes. Do not pull the heat back out because it got worse. Keep it full hot until normal power returns. Partial heat, or heat removed too soon, can aggravate the icing. A Riverside, California pilot proved how sneaky this is (NTSB ERA23FA194). His carburetor heat checked fine at runup. Then he sat at idle through a long ground delay and took off without reapplying it. The ice built while he held short, and the engine quit at about 1,000 feet. FAA guidance in AC 20-113 recommends applying carburetor heat briefly before takeoff after an extended ground delay.

The mixture knob matches fuel flow to air density. As you climb, the air thins while fuel flow stays the same, so the mixture grows too rich. Rich enough, and the spark plugs foul and the engine runs rough. Leaning decreases fuel flow to match the thinner air. Descending reverses the problem. Come down with the mixture still leaned and it becomes too lean. An overly lean mixture can cause detonation, rough running, overheating, and a loss of power. So enrich as you descend, and be at full rich before you enter the pattern, where a go-around demands full power. Your instructor will demonstrate the leaning procedure, and the POH governs.

Your engine is air cooled outside and oil cooled inside. Air enters the cowling, and baffles route it over the cylinder fins. In a long, slow climb that airflow shrinks while power stays high. If temperatures rise, reduce the rate of climb and increase airspeed to restore cooling airflow. Extreme heat costs power, burns oil, and can cause serious engine damage.

Engine oil does more than lubricate. It cools the engine from the inside, removes heat from the cylinders, seals the pistons against the cylinder walls, and carries contaminants away. That is why you check the dipstick on every preflight and never fly below the POH minimum. In flight, two gauges tell the story. Oil pressure should show an indication during engine start, and it should sit in the green range. Oil temperature responds slowly. After a cold start it can take several minutes to move at all. A high oil temperature can mean low oil quantity, a plugged line, or a blocked oil cooler. Watch both gauges, and know your airplane's normal.

## ATTITUDE FLYING AND INTEGRATED FLIGHT INSTRUCTION

**SOURCE** AFH 3C, Ch 3 (via verified summary; see gaps)

Attitude flying is the skill this lesson polishes. Pitch attitude is the angle between the longitudinal axis and the natural horizon. Bank attitude is the angle between the lateral axis and the horizon. Your eyes reference the wings and cowling against the horizon. Attitude control has four parts: pitch control with the elevator, bank control with the ailerons, power for the required thrust, and trim to relieve the pressures once the attitude is set. Yaw control with the rudder cancels adverse yaw and propeller effects.

We teach by the integrated method, using outside references and flight instruments together. The natural horizon is immediate, accurate, and larger than any instrument. So at least 90 percent of your attention belongs outside, on attitude and traffic, and no more than 10 percent inside. Take quick mental snapshots of the instruments to validate performance, then return outside. The most common beginner error is making pitch or bank corrections while still looking inside. The cure for fixation is a conscious return to outside references.

Trim technique follows one rule: attitude first, then trim. Establish the attitude, hold it with pressure, and then trim the pressure away so the airplane holds the attitude on its own. Trying to fly the airplane with the trim is a common fault, even among experienced pilots. A properly trimmed airplane is a mark of good piloting.

## LEAD POINTS: LEVEL-OFFS AND ROLLOUTS

**SOURCE** AFH 3C, Ch 3 (via verified summary; see gaps)

Precision comes from starting early. Level off before the target altitude, leading by about 10 percent of your vertical rate. Climbing at 500 fpm, start 50 feet early; descending at 1,000 fpm, start 100 feet early. Leveling from a climb, keep climb power until the airplane accelerates to cruise speed. Then set cruise power and retrim: pitch, power, trim, in that order.

Rollout from a turn also starts early. Lead the heading by half the bank angle: 15 degrees early for a 30 degree bank. Bank angle changes what the airplane wants to do. At 20 degrees or less, lateral stability slowly levels the wings. From 20 to 45 degrees, the airplane tends to hold the bank with neutral aileron. Past 45 degrees, overbanking tendency steepens the bank unless you hold opposite aileron, because the faster moving outside wing produces more lift.

# THE PRIMARY FLIGHT CONTROLS AND THE COORDINATED TURN

**SOURCE** PHAK 25C, Ch 6, Flight Control Systems + Ailerons + Elevator + Rudder

The ailerons, elevator (or stabilator), and rudder are the primary control system, and they are required to control the airplane safely in flight. Moving any of them changes the airflow and pressure distribution over the airfoil, and that is how you command motion about the three axes. Ailerons control roll about the longitudinal axis. Turn the control wheel right, and the right aileron deflects up, decreasing lift on the right wing. The left aileron deflects down, increasing lift on the left wing, so the airplane rolls right. The elevator controls pitch about the lateral axis. Pull the control column aft, and the trailing edge deflects up. That creates a downward aerodynamic force on the tail, which pitches the nose up about the center of gravity. The rudder controls yaw about the vertical axis. Press the left pedal, and the rudder moves left, creating sideward lift that moves the tail right and yaws the nose left. Rudder effectiveness increases with speed, so slow flight demands larger deflections. Propeller slipstream over the rudder increases its effectiveness.

Here is why your feet matter in every turn. The downward deflected aileron on the rising wing produces more lift, and therefore more drag. That added drag yaws the airplane opposite the direction of the bank, and that is adverse yaw. It is most pronounced at low airspeeds, where control pressures are light and your inputs are large. Rudder counteracts adverse yaw. The amount required is greatest at low airspeed, high AOA, and large aileron deflections. Manufacturers reduce adverse yaw with differential ailerons, frise-type ailerons, coupled ailerons and rudder, or flaperons. But no design eliminates it, so coordinated rudder is still needed.

All turns are coordinated by using ailerons, rudder, and elevator together. Roll in with aileron toward the turn, with simultaneous rudder in the same direction to cancel adverse yaw. Add elevator back pressure, because a turn requires more lift than level flight, and the steeper the turn, the more back pressure. As the desired bank is established, relax the aileron and rudder pressures so the bank stops increasing. But hold the back pressure to hold altitude. Roll out the same way in reverse: aileron and rudder toward the high wing, relaxing back pressure as the bank decreases. That sequence, flown smoothly, is the coordination this lesson is named for.

# SECONDARY CONTROLS: FLAPS AND TRIM

**SOURCE** PHAK 25C, Ch 6, Secondary Flight Controls + Flaps + Trim Tabs

Wing flaps, leading edge devices, spoilers, and trim systems make up the secondary control system. They improve performance or relieve you of excessive control forces. Flaps are the most common high-lift device. Attached to the trailing edge, they increase both lift and induced drag for any given AOA. That allows a compromise between high cruising speed and low landing speed. The four common types are plain, split, slotted, and Fowler. The slotted flap is the most popular today. It ducts high energy air from below the wing over the flap's upper surface. That delays airflow separation, and it produces a much greater increase in maximum lift coefficient than plain or split flaps. Flap extension may cause a nose-up or nose-down pitching moment, depending on the airplane, so anticipate a trim change.

Trim systems exist because the airplane can fly hands-off only in a narrow combination of attitude, airspeed, and power. The most common installation on small airplanes is a single trim tab on the trailing edge of the elevator. The tab moves opposite the elevator. Set nose-up trim, and the tab deflects down, forcing the elevator trailing edge up and the nose up. The procedure is what matters to you. Establish the desired power, pitch attitude, and configuration first, then trim to relieve the control pressures that remain. If you are holding constant back pressure, you need nose-up trim, so keep trimming until the airplane is balanced. Any time power, attitude, or configuration changes, retrim. An airplane in trim is an airplane you can fly with fingertips, and fingertips are what precise maneuvering takes.

# LEFT-TURNING TENDENCIES: TORQUE, SLIPSTREAM, PRECESSION, AND P-FACTOR

**SOURCE** PHAK 25C, Ch 5, Torque and P-Factor

Pilots call the airplane's left-turning tendency torque. It is really four elements, and each one tries to rotate the airplane around at least one axis: torque reaction from the engine and propeller, the corkscrewing effect of the slipstream, gyroscopic action of the propeller, and asymmetric loading of the propeller, called P-factor. Most United States built engines turn the propeller clockwise as seen from the pilot's seat, and all four discussions assume that.

Torque reaction is Newton's third law. As the engine and propeller revolve one way, an equal force tries to rotate the airplane the other way, rolling it left about the longitudinal axis. On the takeoff roll, it also presses more weight onto the left main gear, and the added ground friction pulls the airplane further left. The corkscrew effect comes from the spiraling slipstream. At high propeller speed and low forward speed, the compact spiral strikes the vertical tail and yaws the airplane left about the vertical axis. Takeoff and the power-on stall are exactly that condition. As forward speed increases, the spiral elongates and weakens.

Gyroscopic action is precession. A force applied to the spinning propeller's plane of rotation takes effect 90 degrees ahead, in the direction of rotation. So pitching produces yaw, and yawing produces pitch. It is most prominent in tailwheel airplanes as the tail comes up on the takeoff roll. P-factor appears at high AOA. The descending propeller blade takes a bigger bite of air, with a higher resultant velocity and more thrust, than the ascending blade. The center of thrust shifts right of the propeller disc, yawing the nose left. That is why slow flight, climbs, and power-on stalls all demand right rudder, and why the pressure changes as AOA and power change. Your job is not to memorize which force dominates when. Your job is to apply proper corrective action with the flight controls at all times, and keep the airplane coordinated.

## DUTCH ROLL AND TODAY'S COORDINATION EXERCISE

**SOURCE** PHAK 25C, Ch 5, Free Directional Oscillations (Dutch Roll)

Dutch roll is a coupled lateral and directional oscillation. Roll and yaw are about the same magnitude but out of phase with each other, so the nose traces a figure eight on the horizon. It is usually dynamically stable, but it is undesirable in an airplane because of its oscillatory nature. In most modern airplanes, these free directional oscillations die out on their own in a very few cycles, unless the air stays gusty or turbulent. High-speed swept wing designs are the exception, and aircraft with persistent Dutch roll tendencies use gyro-stabilized yaw dampers. Designers actually prefer a touch of spiral instability over Dutch roll tendencies, so most airplanes are built that way.

The coordination exercise we fly today borrows the name. You roll the airplane bank to bank while you use rudder to keep the nose from wandering. It teaches your hands and feet the timing that cancels adverse yaw as the ailerons work. The exercise trains exactly what the aerodynamics above demand: rudder that arrives with the aileron, in the right amount, without you thinking about it. One day your eyes will stay outside on the horizon while the nose holds still through the rolls. When that happens, your coordination is becoming the subconscious habit the Airplane Flying Handbook says airmanship requires.

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## COMMON ERRORS: TURNS, CLIMBS, AND DESCENTS

**SOURCE** AFH 3C, Ch 3 (via verified summary; see gaps)

Know these before we fly; I will be watching for them. In turns: failing to clear in the direction of the turn; gaining or losing altitude; not holding the bank constant; turning by instrument reference alone; referencing only the nose instead of the wingtips; making skidding flat turns to avoid banking; holding excessive rudder in the turn; and building proficiency in one direction only.

In climbs and climbing turns: chasing the airspeed indicator instead of setting a pitch attitude; pulling to an excessive climb angle; inadequate right rudder, so the airplane yaws left; fixating on the nose and climbing with one wing low; and pushing over too aggressively at level-off.

In descents and gliding turns: failing to clear; not slowing to glide speed before lowering the nose; chasing the airspeed instead of stabilizing the glide; attempting to stretch the glide with back pressure; and slipping or skidding because rudder forces feel lighter with the power off. Every item on these lists is caught the same way: eyes outside, attitude first, coordinated feet.

**LESSON 3 · FOUR FUNDAMENTALS AND COORDINATION**

# *REVIEW QUESTIONS*

*Answer in writing before your preflight briefing. Key at the back of this volume.*

1. In the energy management model, what does the throttle control and what does the elevator control?
2. You want to descend at constant airspeed. Which rule applies and what do you do?
3. You are lower than desired on final but exactly on speed. What is the correction?
4. Altitude high and airspeed fast at the same time: which control fixes it and why?
5. What is adverse yaw and how do you counteract it?
6. Name the four elements that produce the airplane's left-turning tendency.
7. Why does P-factor yaw the airplane left at high angles of attack?
8. What is Dutch roll?
9. In integrated flight instruction, how should your attention be divided between outside and inside the cockpit?
10. When do you begin the level-off from a 500 fpm climb, and when do you begin the rollout from a 30 degree banked turn?
11. What is the correct trim procedure?
12. What do flaps do aerodynamically, and what should you anticipate when extending them?
13. Describe the four strokes of the engine cycle, in order.
14. During runup you get a 75 RPM drop on the left magneto and a 200 RPM drop on the right. What do you do?
15. Why can the engine fire even with the mixture at cutoff and the master switch off?
16. You sump clean, blue fuel after the airplane sat out through a week of heavy rain. Why is that not proof the fuel is safe?
17. The recommended fuel grade is not available. What may you use?

18. In cruise, RPM drops without you touching the throttle. You apply carb heat and the engine runs rougher. What is happening and what do you do?
19. Why do you lean as you climb, and what happens if you descend without enriching?

**LESSON 4** · **PAIRS WITH GROUND MODULES 2 + 4A + 4B**

# *Stall Recovery, Ground Reference, Instrument Intro, Go-Around Intro*

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*This flight asks a lot of you. You will recognize and recover from stalls without direction, and you will fly prescribed ground reference patterns. You will also get your first hood work on the flight instruments, and you will see your first go-around and elementary forced landing. This chapter gives you the stall and spin awareness foundation. It gives you the wind drift theory behind every ground reference maneuver. It explains how your pitot-static and gyroscopic instruments actually work. And it covers the three cardinal principles of the go-around.*

**MEMORY AID** · **FAA**

## Power, Attitude, Configuration

*The three cardinal principles of a go-around, in the order you fly them.*

Power: apply full or maximum allowable takeoff power smoothly and without hesitation.

Attitude: set a climb pitch the airspeed can support. Expect to need forward elevator pressure and right rudder.

Configuration: retract flaps in increments, then gear after a positive rate of climb.

AFH 3C, Ch 9, Go-Arounds (Rejected Landings)

**MEMORY AID** · **NORTH AERO TEACHING AID**

## PARE

*The spin recovery sequence, in the order you fly it.*

Power: throttle to idle.

Ailerons: neutral.

Rudder: full opposite the direction of rotation.

Elevator: briskly forward to break the stall. When rotation stops, neutralize the rudder and pull out of the dive smoothly.

North Aero teaching mnemonic for the recovery sequence in AC 61-67C, Par. 111 + North Aero Ground Module 2

**MEMORY AID · FAA**

### ANDS

*Magnetic compass acceleration error on east and west headings.*

Accelerate: the compass swings toward North.

Decelerate: the compass swings toward South.

The error appears on east and west headings, where magnetic dip tilts the card during speed changes.

PHAK 25C, Ch 8, Acceleration Error + North Aero Ground Module 4A

**MEMORY AID · NORTH AERO TEACHING AID**

### OSUN

*Magnetic compass turning errors: where to stop a turn when rolling out on a compass heading.*

Overshoot South: turning to a southerly heading, the compass lags, so let it pass the target before rolling out.

Undershoot North: turning to a northerly heading, the compass leads, so roll out early.

The PHAK rule of thumb for the amount is 15 degrees plus half your latitude.

North Aero packaging of PHAK 25C, Ch 8, Northerly and Southerly Turning Errors

## STALL AWARENESS AND RECOVERY

**SOURCE** AC 61-67C, Stall and Spin Awareness Training, Par. 100-107

A stall has nothing to do with the engine. It has everything to do with angle of attack: the angle at which the wing's chord line meets the relative wind. As long as the angle of attack stays small enough, the airflow stays attached, and the wing produces lift. Exceed the critical angle of attack for a section of the airfoil, and that section will always stall. The FAA hammers the point in capital letters: a stall is the result of excessive angle of attack, not insufficient airspeed.

Published stall speeds apply only to the specified configuration. Your real stall speed changes with weight, center of gravity, flaps, and load factor. In a level coordinated turn at 60 degrees of bank, the load factor is 2 Gs, and stall speed increases 40 percent. Snow, ice, or frost raises stall speed, so you do not fly with any accumulation.

Learn the warning signs, so recovery becomes instinctive. The controls feel mushy and less effective. The sound of air along the fuselage gets quieter. Buffeting comes just before the stall, and a fixed-pitch propeller loses RPM. The stall warning device alerts you 4 to 8 knots before onset. A warning tells you to increase airspeed by adding power, lowering the nose, and/or decreasing bank.

Recovery is angle of attack first, power second. Reduce the angle of attack at the first indication, so the wing regains lift. Then smoothly apply maximum allowable power to build airspeed and minimize altitude loss. Too much forward pressure unloads the wing into negative G. Hauling the nose up before the wing is flying again causes a secondary stall. Spins are aggravated stalls in a slip or a skid: if a stall does not occur, a spin cannot occur. Your instructor will add realistic distractions during stall work, because that is how these accidents happen.

> *“A stall is a loss of lift and increase in drag that occurs when an aircraft is flown at an angle of attack (AOA) greater than the angle for maximum lift.”*

AC 61-67C, Par. 100

> *“A STALL CAN OCCUR AT ANY AIRSPEED, IN ANY ATTITUDE, AT ANY POWER SETTING.”*

AC 61-67C, Par. 100b

> *“National Transportation Safety Board statistics indicate that most stall/spin accidents result when a pilot is distracted momentarily from the primary task of flying the aircraft.”*

AC 61-67C, Par. 4

GROUND MODULE 2 · AERODYNAMICS AND SPIN AWARENESS

# SPIN PHASES AND THE PARE RECOVERY

> **SOURCE** North Aero Ground Module 2 (Aerodynamics and Spin Awareness) + AC 61-67C, Par. 110-111, Spins and Spin Recovery

You just read that if a stall does not occur, a spin cannot occur. Here is what happens when one does. In a spin, both wings are stalled, but one is stalled more deeply than the other. That lift difference drives the autorotation, and the airplane descends in a corkscrew path at a high angle of attack. A spin moves through phases. The incipient phase runs from the moment the airplane stalls and rotation starts until the spin is fully developed. In a fully developed spin, the rotation rate, airspeed, and vertical speed stabilize from turn to turn, and the flightpath is close to vertical. A flat spin, with the nose near level, may be extremely difficult or even impossible to recover from.

The recovery sequence is worth overlearning, and PARE is how we teach it. Power to idle. Ailerons neutral. Rudder full opposite the rotation. Elevator briskly forward once the rotation slows, enough to break the stall. When rotation stops, neutralize the rudder and pull out of the dive smoothly. Your airplane's POH procedure always governs. Why does rudder come before back pressure? Opposite rudder attacks the lift difference between the wings, which is what sustains the rotation. Pulling back first is the instinctive response, and it is the deadly one. It raises the angle of attack on wings that are already stalled. That deepens the stall and can accelerate the rotation.

Respect the altitude cost. A developed spin takes at least 1,000 feet per turn in most light aircraft. That is why the skidding base-to-final turn is so lethal: there is no room below to recover. Your spin protection at pattern altitude is not the recovery procedure. It is coordination, airspeed, and angle of attack awareness, so the stall never happens. We practice stall work high, after clearing turns, for exactly this reason.

> *“The first step in recovering from an upright spin is to close the throttle completely to eliminate power and minimize the loss of altitude.”*
>
> AC 61-67C, Par. 111, Spin Recovery

# GROUND REFERENCE FOUNDATIONS: WIND DRIFT AND GROUND TRACK

**SOURCE** AFH 3C, Ch 7, Introduction + Maneuvering by Reference to Ground Objects + Drift and Ground Track Control

Ground reference maneuvers combine the four fundamentals into one integrated skill: making the airplane follow a chosen path over the ground. This is the direct foundation for every traffic pattern you will ever fly. Scan across several references rather than fixating on one point. Fixation destroys your ability to judge rate of closure and drift.

These maneuvers happen low, generally between 600 and 1,000 feet AGL, so the setup is a safety exercise in itself. Fly two 90 degree clearing turns, looking left, right, above, and below. Stay at least 500 feet vertically above any obstruction and 2,000 feet horizontally. Keep one or more emergency landing fields in reach. Stay well away from people, congested areas, and livestock. Complete the checklist and make the radio calls. Keep bank at or below 45 degrees, and keep airspeed no greater than maneuvering speed.

To track straight across a crosswind, you angle the nose into the wind. That is a wind correction angle: just enough to cancel the drift. Turning flight adds a wrinkle. At a constant bank angle, the radius of your turn over the ground grows as groundspeed increases and shrinks as it decreases. So to hold a constant radius, you vary the bank. Bank steepest headed downwind, where groundspeed is fastest, and shallowest headed upwind, where it is slowest.

That is why every ground reference maneuver is entered downwind. The steepest required bank comes first, where you can judge it. If it feels too steep, you exit and reposition farther out. You will not calculate correction angles in flight. You read the references and adjust until the drift stops.

# RECTANGULAR COURSE

**SOURCE** AFH 3C, Ch 7, Rectangular Course

The rectangular course is a rehearsal of the airport traffic pattern. You fly a constant altitude, constant airspeed path that holds an equal distance from all four sides of a selected field. Fly parallel to the boundaries, about one-half to three-fourths of a mile outside them, so the references are easy to see. Do not crowd the field. Flying too close forces steep banks, which raise load factor and stall speed, especially in the downwind-to-crosswind turn.

Enter downwind. With the wind on your tail, groundspeed is highest. So the turn onto base begins with a relatively steep bank, and it finishes shallower as the tailwind becomes a crosswind. You turn more than 90 degrees, to crab toward the inside of the course. The turn to upwind starts medium banked, and it is less than 90 degrees because you were already crabbed. The turn onto crosswind rolls in shallow, with groundspeed building from its slowest. It again finishes at less than 90 degrees, with a crab held toward the outside. The final turn back to downwind is medium banked and more than 90 degrees, with groundspeed increasing throughout.

The logic never changes: higher groundspeed means steeper bank. Roll slowly when the wind would drift you into the course, and roll quickly when it would drift you outside. The AFH's common errors list is a ready-made self-critique: failing to clear the area, to establish and hold altitude, to assess wind direction, or to establish the wind correction angle; uncoordinated aileron and rudder, producing slips and skids; rough control usage; poor division of attention; and badly timed turns.

## TRACKING A ROAD AND S-TURNS

**SOURCE** AFH 3C, Ch 7, Drift and Ground Track Control (Tracking Over and Parallel to a Straight Line) + S-Turns

Your first exercise is the simplest. Track a straight road, railroad, or river, flying directly over the line while holding enough wind correction angle to cancel drift. Scan from far ahead to close in. Once you can hold the line, offset and fly a parallel path no more than three-fourths of a mile from the reference, still crabbed, still parallel.

S-turns put that skill into turning flight: two opposite but equal half circles across a straight-line reference. Enter downwind. Cross the road at a 90 degree angle, and immediately begin a 180 degree constant-radius turn. Roll quickly to the steepest bank of the maneuver, then shallow the bank as groundspeed falls. Time the rollout so the wings come level exactly as you re-cross the road at 90 degrees. Then immediately roll into the opposite turn. That turn begins upwind, with a gentle, shallow bank that steepens as the wind comes behind you.

Throughout, the airplane's heading leads its ground position on the downwind half and lags it on the upwind half. That happens because you hold a wind correction angle inside the turn. The common errors mirror the rectangular course list, and they are attention failures more than hand-flying failures. These maneuvers exist to build division of attention.

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## INSTRUMENT INTRODUCTION: THE PITOT-STATIC INSTRUMENTS

**SOURCE** PHAK 25C, Ch 8, Pitot-Static Flight Instruments

Three of your instruments run on air pressure. The pitot tube senses ram (impact) pressure, and it feeds only the airspeed indicator. The static ports sense undisturbed ambient pressure. They feed the airspeed indicator, altimeter, and vertical speed indicator. Check both on every preflight.

The altimeter is an aneroid barometer: a pressure gauge with no liquid inside. Sealed wafers expand as static pressure drops and contract as it rises, driving the needles. It measures height above a given pressure level. So it is only honest with the current altimeter setting in the window. Fly from high pressure toward low without resetting, and you are lower than indicated. Colder than standard air does the same thing: from hot to cold, look out below. Know the five kinds of altitude. Indicated altitude is read directly with the current setting. True altitude is the actual height above sea level. Absolute altitude is the height above the ground. Pressure altitude is the indicated altitude with 29.92 set. Density altitude is pressure altitude corrected for nonstandard temperature, and it is the one that drives performance.

The vertical speed indicator compares direct static pressure against static pressure delayed through a calibrated leak. Needle direction gives instant trend information. But the rate indication lags 6 to 9 seconds, so do not chase it. The airspeed indicator measures the difference between pitot and static pressure. Indicated airspeed is what you read. Calibrated airspeed corrects installation error. True airspeed increases over calibrated about 2 percent per 1,000 feet, and groundspeed is true airspeed corrected for wind. The color arcs encode limits. White is the flap operating range, from VS0 to VFE. Green is the normal range, from VS1 to VNO. Yellow is smooth air only, and the red line is VNE. The numbers for your airplane come from the POH only.

Blockages matter. If the pitot tube clogs but its drain stays open, the airspeed indicator drops to zero. If both clog, trapped pressure makes the airspeed indicator behave like an altimeter, misreading as you climb or descend. A blocked static system corrupts all three instruments. That is why your airplane has an alternate static source. Expect slightly different readings on it, and check the POH for corrections.

> *“Trapped static pressure causes the altimeter to freeze at the altitude where the blockage occurred. In the case of the VSI, a blocked static system produces a continuous zero indication.”*

PHAK 25C, Ch 8, Blocked Static System

# INSTRUMENT INTRODUCTION: THE GYROSCOPIC INSTRUMENTS

**SOURCE** PHAK 25C, Ch 8, Gyroscopic Flight Instruments

The attitude indicator, heading indicator, and turn coordinator work because a spinning rotor obeys two properties. Rigidity in space keeps the gyro fixed in its spin plane while the airplane rotates around it. Precession makes a deflecting force act 90 degrees later in the direction of rotation. Precession lets an instrument sense rate of turn. It also makes gyros slowly drift, as bearing friction nudges them.

These instruments run on a vacuum or pressure system, or on electricity. Most airplanes split the sources, so a single failure still leaves bank information. A failing vacuum system means sluggish, unreliable gyros, so scan the suction gauge.

The attitude indicator is the only instrument that shows pitch and bank directly and instantly. A miniature airplane flies against a gyro-stabilized horizon bar. Under the hood, it is your substitute for the natural horizon. The heading indicator is a mechanical aid to the magnetic compass. Friction precession, plus the Earth's own 15 degrees per hour of rotation, makes it drift. So check it about every 15 minutes, and reset it to the compass in straight-and-level, constant-speed flight.

The turn coordinator senses roll rate first, then rate of turn. The second index mark is a standard rate turn of 3 degrees per second. Below it sits the inclinometer, which reports coordination. Ball inside the turn means slip, and ball outside means skid. The fix either way is to step on the ball. You will use these today for turns to headings and descents under the hood. So know what each one tells you, and how quickly to trust it.

> *“Rigidity in space refers to the principle that a gyroscope remains in a fixed position in the plane in which it is spinning.”*

PHAK 25C, Ch 8, Gyroscopic Principles

> *“Precession is the tilting or turning of a gyro in response to a deflective force. The reaction to this force does not occur at the point at which it was applied; rather, it occurs at a point that is 90° later in the direction of rotation.”*

PHAK 25C, Ch 8, Gyroscopic Principles

**GROUND MODULE 4A · INSTRUMENT SYSTEMS**

# AIRSPEED LIMITS, COMPASS ERRORS, AND REQUIRED EQUIPMENT

**SOURCE** North Aero Ground Module 4A (Instrument Systems) + PHAK 25C, Ch 8, Airspeed Indicator Markings, Compass Errors, and Blocked Pitot System + 14 CFR 91.205(b)

You met the airspeed color arcs earlier in this chapter. Now attach exact meanings, because examiners love this instrument. The white arc is the flap operating range. Its bottom is VS0, the power-off stall speed in the landing configuration. Its top is VFE, the maximum speed with the flaps extended. Extend full flaps above VFE and the loads can damage the flap hinges and tracks, or deploy the flaps asymmetrically. The green arc is the normal operating range. It runs from VS1, the stall speed in a specified clean configuration, up to VNO, the maximum structural cruising speed. Above VNO lies the yellow caution arc: smooth air only. The red line is VNE, the never-exceed speed. One critical speed is not painted on the dial at all: VA, the maneuvering speed. It lives on a placard and in the POH, and it decreases as the airplane gets lighter.

The magnetic compass is honest only in straight, level, unaccelerated flight. Magnetic dip tilts the card during turns and speed changes, and the errors are predictable. On east or west headings, acceleration swings the indication toward north, and deceleration swings it toward south. Remember ANDS: Accelerate North, Decelerate South. In turns, the compass leads through south and lags through north. So let the card pass your target on southerly headings, and roll out early on northerly headings. Remember OSUN: Overshoot South, Undershoot North. This is also why you reset the heading indicator to the compass only in steady, wings-level, constant-speed flight.

Your pitot tube can ice over in visible moisture, and the airspeed indicator dies with it. That is what pitot heat is for. Verify it is operational before flight, and turn it on before entering visible moisture. The POH gives the procedure for your airplane. The preflight matters just as much. Inspect the pitot opening on every walkaround, and keep the cover on when the airplane is parked so insects stay out.

Finally, know that the required instrument list is regulation, not opinion. For day VFR, 14 CFR 91.205(b) requires items including: airspeed indicator, altimeter, magnetic direction indicator, tachometer for each engine, oil pressure and oil temperature gauges, a fuel gauge for each tank, safety belts, and an anticollision light system on newer airplanes. You will study the full list, and the rules for inoperative equipment, later in the course. For now, know the rule exists and where to find it.

> *"For VFR flight during the day, the following instruments and equipment are required: (1) Airspeed indicator. (2) Altimeter. (3) Magnetic direction indicator. (4) Tachometer for each engine."*

14 CFR 91.205(b), excerpt

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GROUND MODULE 4B · UNUSUAL ATTITUDES AND EMERGENCY PROCEDURES

## SPATIAL DISORIENTATION: TRUST THE INSTRUMENTS

**SOURCE** North Aero Ground Module 4B (Unusual Attitudes) + PHAK 25C, Ch 17, Spatial Disorientation and Illusions

Today's hood work has a life-or-death reason behind it. Your inner ear senses turns with fluid-filled canals. In a prolonged, constant-rate turn the fluid catches up with the canal walls, and the sensation of turning fades to nothing. Rolls slower than about 2 degrees per second never register at all. With a horizon in view, your eyes override these false signals. Take the horizon away, in cloud, haze, or a dark night over water, and your body starts to lie.

Two illusions matter most right now. The leans is the most common. You level the wings after a gradual turn you never noticed, and it feels like banking the opposite way. So you lean, or roll back toward the original turn. The graveyard spiral is the killer version. In a prolonged turn you feel wings-level while altitude bleeds away. Sensing the descent, you pull back. With the wings still banked, pulling tightens the spiral and steepens the descent. This pattern killed a 310-hour private pilot in haze off Martha's Vineyard in 1999. It also killed an airline transport pilot and flight instructor near Minden, Nevada in 2018. Certificates and hours provide no immunity.

The defense is absolute: when your body and your instruments disagree, the instruments win. Caught nose low and turning, reduce power first, level the wings on the attitude indicator, and only then raise the nose. Raising the nose while banked tightens the turn and loads the wings. And as a VFR pilot, your best move is to never need this skill. If the horizon ahead is dissolving, turn around while you still have one behind you. We go much deeper on illusions and instrument flying in Phase 2.

> *"Spatial disorientation specifically refers to the lack of orientation with regard to the position, attitude, or movement of the airplane in space."*

PHAK 25C, Ch 17, Spatial Disorientation and Illusions

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## THE GO-AROUND

**SOURCE** AFH 3C, Ch 9, Go-Arounds (Rejected Landings)

A go-around is a normal maneuver, not an apology. ATC instructions, a runway hazard, overtaking traffic, wind shear, wake turbulence, mechanical trouble, or an unstable approach are all valid reasons to reject a landing. The maneuver becomes dangerous only when it is delayed unduly or flown improperly. The AFH names the two sources of delay. Landing expectancy is the anticipatory belief that things are not as threatening as they are. Pride is the mistaken belief that going around admits failure.

Power comes first. Apply full or maximum allowable takeoff power smoothly, without hesitation, and hold it until flying speed and controllability are restored. Abrupt throttle movement can make some engines falter. Carburetor heat comes off for maximum power, as applicable.

Attitude comes second. The airplane is trimmed for low airspeed, so the sudden power pitches the nose up and yaws it left. Expect considerable forward elevator pressure and sufficient right rudder. Do not pitch up for a climb the airspeed cannot support. If airspeed is insufficient, it may be necessary to briefly lower the nose. Once climbing, trim roughly, then fine tune the trim when things stabilize.

Configuration comes third. Stop the descent and set the climb attitude first. Then retract the landing flaps partially, or to the takeoff position, as the manufacturer recommends. Do it in increments, so the airplane can accelerate. Dumping full flaps at once can settle you back into the ground. Gear, where applicable, comes up after the flaps and a positive rate of climb. Finally, respect ground effect. The apparent cushion near the surface is borrowed performance, created by reduced induced drag. Climb out of it too soon, and you may be unable to climb at all. Common errors: failing to recognize the need; indecision; delay; late or abrupt power; improper pitch; wrong configuration sequence; premature climb out of ground effect; and inadequate right rudder.

> *“The proper execution of a go-around maneuver includes three cardinal principles: 1. Power 2. Attitude 3. Configuration”*

AFH 3C, Ch 9, Go-Arounds (Rejected Landings)

> *“Power is the pilot's first concern. The instant a pilot decides to go around, full or maximum allowable takeoff power should be applied smoothly, without hesitation, and held until flying speed and controllability are restored.”*

AFH 3C, Ch 9, Go-Arounds (Rejected Landings), Power

# EMERGENCY LANDING CONCEPTS AND THE EMERGENCY DESCENT

**SOURCE** AFH 3C, Ch 18, Emergency Landings + Basic Safety Concepts + Emergency Descents

This lesson introduces the elementary forced landing and the emergency descent. A forced landing is an immediate landing, on or off an airport, required because further flight is impossible. Engine failure is the classic example. A precautionary landing is a premeditated landing while flight is still possible but inadvisable. Reasons include deteriorating weather, being lost, fuel shortage, or developing engine trouble. Ditching is either one done on water.

The AFH identifies three psychological traps: reluctance to accept the emergency, undue concern about getting hurt, and the desire to save the airplane. All three delay the actions that keep you alive, like lowering the nose to maintain flying speed and committing to the best field within reach. The airplane is dispensable. Let the wings, gear, and fuselage bottom absorb the energy, so the cabin stays intact.

Physics sets the priorities. Destructive energy rises with the square of groundspeed. So touching down at the lowest possible controllable airspeed, under control, is worth more than any perfect field. A typical light airplane cabin protects its occupants at 9G forward. At that deceleration, a 50 mph touchdown needs only about 9.4 feet of stopping distance.

The emergency descent gets you down fast, for a fire, loss of pressurization, or anything demanding immediate descent. Unless the manufacturer says otherwise: power to idle, and propeller to low pitch. Set gear and flaps as the POH recommends for maximum drag. Never exceed VNE, VLE, or VFE, as applicable. Descend in a 30 to 45 degree bank, for positive load factor and traffic scanning. Recover with enough altitude to level off or land.

> *"The success of an emergency landing is as much a matter of the mind as of skills."*

AFH 3C, Ch 18, Psychological Hazards

> *"The overall severity of a deceleration process is governed by speed (groundspeed) and stopping distance. The most critical of these is speed; doubling the groundspeed means quadrupling the total destructive energy and vice versa."*

AFH 3C, Ch 18, Basic Safety Concepts

> *"An emergency descent is a maneuver for descending as rapidly as possible to a lower altitude or to the ground for an emergency landing."*

AFH 3C, Ch 18, Emergency Descents

**LESSON 4 · STALL RECOVERY, GROUND REFERENCE, INSTRUMENT INTRO, GO-AROUND INTRO**

# *REVIEW QUESTIONS*

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*Answer in writing before your preflight briefing. Key at the back of this volume.*

1. What is a stall, and what single factor causes it?
2. What are the first two actions in a stall recovery, in order?
3. Why do you enter every ground reference maneuver on the downwind side?
4. In a constant-radius turn over the ground, when is your bank steepest and when is it shallowest?
5. How far from the field boundaries do you fly a rectangular course, and why not closer?
6. Your static ports ice over completely in flight. What do your altimeter and VSI do?
7. What two gyroscopic principles make the gyro instruments work?
8. What are the three cardinal principles of a go-around, in order, and what pitch and yaw forces should you expect?
9. In a forced landing, what matters more than reaching a perfect field?
10. Name the phases of a spin, and describe what defines a fully developed spin.
11. Recite the PARE spin recovery, and explain why rudder comes before elevator.
12. What speed marks the top of the green arc, and which critical speed appears nowhere on the dial?
13. You accelerate on a westerly heading. What does the magnetic compass show, and which memory aids cover the compass errors?
14. Name five instruments 14 CFR 91.205(b) requires for day VFR flight.
15. What is the graveyard spiral, and what is the correct recovery?

**LESSON 5** · **PAIRS WITH GROUND MODULE 5**

# *Emergency Procedures and Instrument Flying*

*This flight puts emergency procedures front and center. You will fly the emergency descent, review emergency equipment and survival gear concepts, and use radar services, including flight following. You will also review instrument and ground reference work at another airport. This chapter covers the full emergency toolkit from the Airplane Flying Handbook and the AIM. It covers who has authority in an emergency, how to ask for help and what help exists, how to put an airplane down off-airport, and how to survive an accidental flight into the clouds.*

**MEMORY AID** · **FAA**

### MAYDAY and PAN-PAN

*The two emergency radio signals, and which condition each one belongs to.*

MAYDAY: distress. Serious or imminent danger requiring immediate assistance. It commands radio silence on the frequency and has priority over all other traffic.

PAN-PAN: urgency. Concern about safety requiring timely, but not immediate, assistance. It has priority over everything except distress.

Speak the signal three times to open the transmission. Then give the station you are calling, your identification, the problem, your intentions, and your position.

AIM 6-3-1 + AIM Pilot/Controller Glossary

**MEMORY AID** · **FAA**

### ELT Facts

*The emergency locator transmitter facts you should be able to recite before this flight.*

An armed ELT activates on its own under crash forces.

It then transmits continuously for at least 48 hours.

Satellites no longer monitor the old 121.5 MHz analog signal. The 406 MHz digital ELT is registered to you and is detected almost instantly.

Monitor 121.5 in flight when able, and again before engine shutdown, to catch activations, including your own.

AIM 6-2-4, Emergency Locator Transmitter

## PILOT AUTHORITY AND THE DECISION TO ASK FOR HELP

**SOURCE** AIM Ch 6, Section 1, 6-1-1 + 6-1-2

In an emergency, you are in charge. The AIM states the rule bluntly: the pilot in command is directly responsible for the operation of the aircraft, and is the final authority over it. In an emergency that requires immediate action, you may deviate from any rule in 14 CFR part 91 Subparts A and B, as far as needed to meet that emergency. If you use that authority and deviate from an ATC clearance, notify ATC as soon as possible and get an amended clearance.

An emergency is either a distress condition or an urgency condition. Pilots rarely hesitate over true distress, because fire, mechanical failure, and structural damage are clear. The trap is the urgency condition: a situation that is not yet perilous, but could turn catastrophic. The AIM's standard is earlier than most students expect. It deserves memorizing.

The moment you are doubtful about position, fuel endurance, or weather, ask for help rather than waiting until the situation becomes distress. Radio, radar, direction finding stations, and other aircraft are ready and willing. The AIM is unusually direct about the cost of pride here: delay has caused accidents and cost lives. Safety is not a luxury. Take action.

> *“The pilot-in-command of an aircraft is directly responsible for and is the final authority as to the operation of that aircraft. In an emergency requiring immediate action, the pilot-in-command may deviate from any rule in 14 CFR part 91, Subpart A, General, and Subpart B, Flight Rules, to the extent required to meet that emergency.”*

AIM 6-1-1

> *“An aircraft is in at least an urgency condition the moment the pilot becomes doubtful about position, fuel endurance, weather, or any other condition that could adversely affect flight safety.”*

AIM 6-1-2

# DISTRESS, URGENCY, MAYDAY, AND PAN-PAN

**SOURCE** AIM Ch 6, Section 3, 6-3-1 + 6-3-2 + AIM Pilot/Controller Glossary

The two conditions have precise definitions in the Pilot/Controller Glossary, quoted below. Distress means serious or imminent danger that needs immediate assistance. Urgency means concern about safety that needs timely, but not immediate, assistance, a potential distress condition. Match the radio signal to the condition. Say MAYDAY for distress and PAN-PAN for urgency, each preferably spoken three times to open the transmission.

Those words carry legal weight on the frequency. Distress calls have absolute priority over all other communications. The word MAYDAY commands radio silence on the frequency in use. Urgency calls have priority over everything except distress. Address the facility you are already talking to. If you are not receiving services, call the facility responsible for the area, and if nobody answers, broadcast to any station. The emergency frequency is 121.5 MHz, and its military counterpart is 243.0 MHz. Direction finding stations, most civil towers, military towers, and radar facilities guard 121.5.

When a distress or urgency condition exists, the AIM tells you to act at once. The steps are not necessarily in this order. Climb if possible for better communications and radar detection, and squawk 7700 if you cannot raise anyone. Then transmit as many parts of the emergency message as needed, preferably in order. Start with the MAYDAY or PAN-PAN signal and the station you are addressing, then your aircraft identification and type. State the nature of the problem and the weather. Give your intentions and request. Report your position and heading, or your last known position if lost. Add your altitude, your fuel remaining in minutes, and the number of people on board, plus anything else useful.

After contact, comply, cooperate, and ask questions when you do not understand. Do not change frequency unless you absolutely must, and if you do have to change, say where you are going first.

> *“A condition of being threatened by serious and/or imminent danger and of requiring immediate assistance.”*

AIM Pilot/Controller Glossary, Distress

> *“A condition of being concerned about safety and of requiring timely but not immediate assistance; a potential distress condition.”*

AIM Pilot/Controller Glossary, Urgency

> *“The initial communication, and if considered necessary, any subsequent transmissions by an aircraft in distress should begin with the signal*

> *MAYDAY, preferably repeated three times. The signal PAN-PAN should be used in the same manner for an urgency condition.”*
>
> AIM 6-3-1

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## RADAR SERVICES AND FLIGHT FOLLOWING

> **SOURCE** AIM Ch 4, Section 1, 4-1-15 Radar Traffic Information Service + 4-1-18 Terminal Radar Services for VFR Aircraft

Flight following is the everyday name for radar traffic information service. A radar facility advises you of targets close enough to your position or route to warrant attention, so you know where to look and can act if needed. Traffic is issued as a clock position based on your ground track. You also get distance in nautical miles, direction of movement, and type and altitude if known. For example: traffic 10 o'clock, 3 miles, westbound. The controller sees your track, not your heading, so your crab angle can shift where the traffic actually appears. Search a wide arc around the called position.

Understand what the service is not. It never relieves you of see-and-avoid responsibility. It is also workload permitting: radar limitations, traffic volume, controller workload, and frequency congestion can all prevent it. Controllers have complete discretion to provide it, decline it, or terminate it, and vectors away from traffic come only if you request them. While receiving advisories, monitor the frequency at all times. Tell the controller before you change frequency. Squawk 1200 afterward if applicable.

Terminal radar facilities offer basic radar service for VFR aircraft. It adds safety alerts, traffic advisories, and limited vectoring on a workload permitting basis. At certain locations, it also adds sequencing into the pattern. This lesson's flight goes to another airport, so flight following is the professional habit to build. It gives you an extra set of eyes and a recorded position for search and rescue, and it means a controller is already talking to you if an emergency starts.

> *“This service is not intended to relieve the pilot of the responsibility for continual vigilance to see and avoid other aircraft.”*
>
> AIM 4-1-15

> *“Many factors, such as limitations of the radar, volume of traffic, controller workload and communications frequency congestion, could prevent the controller from providing this service. Controllers possess complete discretion for determining whether they are able to provide or continue to provide this service in a specific case.”*
>
> AIM 4-1-15

## EMERGENCY SERVICES: RADAR HELP, 7700, THE ELT, AND SEARCH AND RESCUE

**SOURCE** AIM Ch 6, Section 2, 6-2-1 + 6-2-2 + 6-2-4 + 6-2-6

Radar-equipped ATC facilities can give vectors and navigation help to a VFR aircraft in difficulty, whenever you can talk to the controller and are within radar coverage. The guidance is advisory. Responsibility for flying the airplane safely stays with you, and a vector is not permission to violate the regulations. The AIM's guidance for a VFR pilot facing weather is specific. If a course of action permits flight and a safe landing in VFR conditions, choose VFR rather than accepting vectors into instrument conditions. If continued VFR flight is not possible, and you are not instrument rated, say so and declare a distress condition.

In a distress or urgency condition, squawk 7700 with altitude reporting and establish communications immediately. Code 7700 normally triggers an alarm at every control position. But you may be outside radar coverage, so keep squawking and keep trying to make contact.

The emergency locator transmitter, or ELT, is required for most general aviation airplanes. When armed, it activates on its own under crash forces and then transmits continuously for at least 48 hours. Satellites no longer monitor the old 121.5 MHz analog signal. The 406 MHz digital ELT is registered to you. Satellites detect it almost instantly, and it gets a response in minutes rather than hours. That is why the FAA and NOAA strongly encourage the upgrade. Monitor 121.5 in flight when able, and again before engine shutdown, to catch ELT activations, including your own.

Search and rescue works best when someone knows to start looking. A filed VFR flight plan is the most timely sign that an aircraft is overdue. A search begins if you have not closed the plan within one half hour after your ETA. Closing the flight plan after landing is your responsibility. It is not automatic. For flight over uninhabited terrain, carry survival equipment that fits the climate and terrain, and know how to use it.

## THE EMERGENCY LANDING, START TO FINISH

**SOURCE** AFH 3C, Ch 18, Emergency Landings + Basic Safety Concepts + Terrain Selection + Airplane Configuration + Approach + Terrain Types

Lesson 4 introduced the concepts. Now build the full sequence. Know the three types: a forced landing is immediate, because flight cannot continue. A precautionary landing is premeditated, made while flight is still possible but inadvisable. A ditching is either one on water. A precautionary landing made early, with power available, is generally far less hazardous than the forced landing it prevents. Fight the three psychological traps: reluctance to accept the situation, fear of injury, and the urge to save the airplane at the expense of the people in it.

Control what matters most. Loss of attitude and sink rate control at touchdown is the most critical error. A high sink rate with a flat touchdown, a very nose-low attitude, or a steep bank near the ground each turns a survivable landing into something worse. Touch down at the lowest possible controllable airspeed, wings level, using every aerodynamic device available.

Pick terrain from the general area down to the specific spot, remembering that appearances from altitude deceive. Do not keep changing your mind. As a general rule, do not change fields more than once. Dense crops and brush absorb energy and act like arresting gear. Now configuration: flaps lower touchdown speed, but they cost glide distance if extended early, so use them on final, once the field is made. In a retractable, gear position follows the AFM/POH and the terrain. Shut off the electrical system before touchdown to reduce fire risk, but only after you no longer need electrical power. And never let configuration tasks compete with positive control of the airplane on final.

Plan the approach around wind, the field's dimensions and slope, and the obstacles on final, and accept that the three rarely cooperate. Sometimes the unobstructed approach beats the into-the-wind approach. In trees, use normal landing configuration and minimum controllable groundspeed into the wind. Contact the branches nose-high at minimum indicated airspeed, but not below stall. On water or snow, expect to lose depth perception over a smooth surface, and fly it on rather than flaring blind.

> *“A precautionary landing, generally, is less hazardous than a forced landing because the pilot has more time for terrain selection and the planning of the approach.”*

AFH 3C, Ch 18, Types of Emergency Landings

> *“Experience shows that a collision with obstacles at the end of a ground roll or slide is much less hazardous than striking an obstacle at flying speed before the touchdown point is reached.”*

AFH 3C, Ch 18, Approach

## ENGINE FAILURE AFTER TAKEOFF AND THE TURN-BACK TRAP

**SOURCE** AFH 3C, Ch 18, Engine Failure After Takeoff (Single-Engine)

If the engine fails during the initial climb, the first action is always the same: lower the nose and establish the proper glide attitude. Landing straight ahead, or with only a slight turn, is usually the lowest risk option. The turn back to the runway has a name in aviation: the impossible turn. The AFH's arithmetic shows why.

In the FAA's example, the engine fails at 300 feet AGL. Allow a realistic 4 seconds of reaction time. A standard rate turn needs a full minute to reverse course 180 degrees. After the reversal, you are offset thousands of feet to the side of the runway. You still need to turn roughly 45 degrees more, about 225 degrees of total turning. At a typical gliding descent rate, the airplane arrives well over a thousand feet lower than where the failure occurred, far below a 300 foot starting point. A tighter, steeper turn shortens the path, but it raises stall speed close to the ground, invites an accelerated stall or a cartwheel, and finishes with a fast downwind touchdown.

The maneuver is an unacceptable risk for students, low-time pilots, and anyone who has not trained for it in that make and model at a safe altitude. Practice at altitude tells you your real altitude loss, and you should assume the high end of whatever you practiced. The takeaway for this stage of training is simple. Brief the failure options before every takeoff, and default to lowering the nose and landing mostly straight ahead.

> *“The pilot should not attempt a turn back unless a successful turn back will result.”*
>
> AFH 3C, Ch 18, Engine Failure After Takeoff (Single-Engine)

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## EMERGENCY DESCENTS, FIRES, AND SYSTEM FAILURES

**SOURCE** AFH 3C, Ch 18, Emergency Descents + In-Flight Fire + System Malfunctions + Door Opening In-Flight

The emergency descent gets you down as rapidly as possible without exceeding structural limits. Set power to idle and the propeller to low pitch, with gear and flaps per the manufacturer's recommendation for maximum drag. Bank 30 to 45 degrees for positive load factor and traffic scanning. Keep airspeed inside VNE, VLE, and VFE as applicable.

Fires come in three kinds. An engine fire is usually fuel on a hot surface. The generic response, always subordinate to your POH, is mixture to idle cutoff and fuel selector off. Let the engine burn the fuel already in the lines, and do not restart if the flames die. Plan a forced landing. An electrical fire announces itself with the distinct odor of burning insulation. Isolate the faulty circuit if you can; otherwise, turn the master and alternator off and land as soon as possible. A cabin fire makes two demands at once: attack the fire, and get on the ground quickly. Mind your vents, because opening them can feed the fire.

Two quieter failures round out the set. An electrical system failure is usually the alternator, and battery endurance depends entirely on load. So shed everything nonessential, tell ATC while you still have a radio, and land at the nearest suitable airport. A blocked or partially blocked static system is sneaky, because the instruments lie in a consistent, believable way. Confirm it with the alternate static source, then use the alternate for the rest of the flight.

Finally, the door that pops open in flight. It is a distraction, not an emergency. A cabin door opening seldom if ever compromises the airplane's ability to fly. Fly the airplane, climb to pattern altitude, and land normally. The accident record on open doors is a record of pilots who stopped flying, not doors that caused crashes.

> *“A fire in-flight demands immediate and decisive action.”*
>
> AFH 3C, Ch 18, In-Flight Fire

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GROUND MODULE 5 · SYSTEMS 2 AND EMERGENCY PROCEDURES

## FLIGHT CONTROL AND LANDING GEAR MALFUNCTIONS

> **SOURCE** AFH 3C, Ch 18, Flight Control Malfunction/Failure + Landing Gear Malfunction

The flaps can fail you in two ways, and the simple one is refusing to extend. In light airplanes, a no-flap approach and landing is not particularly difficult or dangerous. But plan for it. A no-flap landing can require up to 50 percent more runway. Fly the pattern in a relatively nose-high attitude to hold altitude, and fly it wider and longer, because losing altitude is harder without flap drag. Do not dive at the runway to fix a high final. On final, the nose-high attitude can hide the runway and can feel like the edge of a stall. Expect considerable float in the round out. Do not force the airplane on at high speed, and do not flare excessively, because the tail can strike the runway.

An asymmetric flap, or split flap, is the harder failure. One flap moves and the other stays put. The clue is a pronounced roll toward the wing with the least flap deflection, right as the flaps run. Counter the roll with opposite aileron. The extended flap drags on its side, so the yaw takes substantial opposite rudder, and you are now cross-controlled. Nearly full aileron may be needed at approach speed. Do not land with a crosswind from the side of the deployed flap, because the extra roll control it demands may not be left. Fly the approach faster than normal. Then fly the airplane onto the runway with a safe margin above the flaps-up stall speed, because an excessive flare invites an asymmetric stall.

Most elevators run on two cables, an up cable and a down cable, and losing one usually costs you part of the pitch control, not all of it. Lose the up cable and the yoke comes aft with no response, but forward yoke still lowers the nose. Trim becomes your other pitch control. Apply considerable nose-up trim, hold the attitude you want with forward pressure, and release that forward pressure to flare for landing. Lose the down cable and the logic reverses: nose-down trim and back pressure. Even a broken linkage that leaves the elevator free to weathervane can be managed, because the trim tab can raise or lower the elevator within limits. Trim tabs are weaker than the normal linkage at low airspeed, but usually effective enough to bring about a safe landing. A fully jammed elevator leaves only combinations of power and flap extension for limited pitch control, and a landing in that condition is genuinely problematic. Declare the emergency.

In a retractable, confirm the gear has truly failed using both the normal and the alternate extension methods in the AFM/POH before accepting a gear-up landing. Then set up the best outcome. Pick an airport with crash and rescue facilities if you can, and do not hesitate to ask for the equipment to stand by. A smooth, hard-surface runway usually causes less damage than rough grass, though pavement can spark. Consider burning off excess fuel, which cuts both landing speed and fire potential. If only one main gear leg refuses to extend, burn fuel from that side when practicable, so the lighter, unsupported wing can be held off until the last possible moment. On the rollout, stay off the brakes unless they are absolutely necessary to avoid a collision.

> *“The roll encountered in a split flap situation is countered with opposite aileron. The yaw caused by the additional drag created by the extended flap requires substantial opposite rudder resulting in a cross-control condition.”*

AFH 3C, Ch 18, Asymmetric (Split) Flap

# INADVERTENT VFR FLIGHT INTO IMC

**SOURCE** AFH 3C, Ch 18, Inadvertent VFR Flight Into IMC

Today's hood work is not about precision instrument flying. It exists for one hard reason: a VFR pilot without instrument training who flies into cloud typically loses control in about 10 minutes. The condition is defined by capability, not weather. Any time you cannot maintain attitude control by reference to the natural horizon, you are in instrument conditions. That is a genuine emergency. The goals, in order, are recognition and acceptance, maintaining control, and obtaining assistance.

Control comes from believing the instruments and disbelieving your body. The inner ear generates false sensations in cloud and cannot be trusted. Keep the wings level and trim for hands-off level flight. Make small, smooth changes, no more than one bar width of pitch on the attitude indicator. The turn is the most dangerous maneuver, because over-controlling the bank leads to the graveyard spiral. Use the smallest practical bank angle, never more than 10 degrees, and make large heading changes a few degrees at a time.

For a climb, raise the miniature airplane no more than one bar width, add power in small increments, and expect a left-turning tendency. For a descent, reduce power in small increments, keep the wings level, and never let the descent rate exceed 500 feet per minute. Avoid combining maneuvers. Do not turn while climbing or descending. Then get help. Confess the situation to ATC, and do not let a controller's pace rush you. It is reasonable to ask the controller to slow down. When you regain visual conditions, give yourself time to reorient before landing.

**LESSON 5 · EMERGENCY PROCEDURES AND INSTRUMENT FLYING**

# *REVIEW QUESTIONS*

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*Answer in writing before your preflight briefing. Key at the back of this volume.*

1. What authority does the pilot in command have in an emergency?
2. Define distress and urgency in the AIM's terms.
3. When are you in at least an urgency condition?
4. Which radio signal goes with which condition, and how is it spoken?
5. What do you squawk in an emergency, and what frequency can you use if you cannot raise anyone?
6. Does flight following relieve you of traffic responsibility?
7. The engine fails at 300 feet AGL after takeoff. What do you do first, and why not turn back?
8. Why is a 406 MHz ELT preferred over the older 121.5 MHz type?
9. Who closes a VFR flight plan, and what happens if it is not closed?
10. You are VFR and blunder into cloud. What are your bank and descent limits while getting out?
11. The flaps will not extend. What changes about your landing?
12. How do you recognize a split flap, and how do you handle it?
13. You lose up-elevator response in flight. How can you still control pitch and land?

LESSON 6 · PAIRS WITH REVIEW R1 (PHASE 1 CUMULATIVE)

# Maneuver Review and Emergency Procedures

*This is a consolidation flight. You will fly a comprehensive maneuvers review, practice emergency procedures, and work on approaches and landings. That prepares you for concentrated takeoff and landing training. The reading is correspondingly light. This chapter gives you the decision-making and situational awareness framework from PHAK Chapter 2. It also gives you a distilled review of the common errors the FAA lists for the maneuvers you have flown so far.*

MEMORY AID · FAA

## 3P

*The continuous decision loop you run whenever something changes in flight.*

P: Perceive the hazards, using the PAVE checklist.

P: Process their impact on flight safety, using the CARE checklist.

P: Perform the best course of action, choosing risk controls with the TEAM checklist.

PHAK 25C, Ch 2, The Decision-Making Process (3P Model)

MEMORY AID · FAA

## DECIDE

*A six-step model for working a developing problem when you have time to think.*

D: Detect that something has changed.

E: Estimate the need to react, based on the situation.

C: Choose a course of action.

I: Identify solutions.

D: Do the necessary actions.

E: Evaluate the effects of the actions.

PHAK 25C, Ch 2, The DECIDE Model

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### 5P Check

*A scheduled review of five areas at the key decision points of every flight.*

The five areas: Plan, Plane, Pilot, Passengers, and Programming.

Run it at five points: preflight, before takeoff, at the midpoint of the flight, before descent, and before entering the pattern.

The easiest place to cancel a flight is the first of those points, not the last.

PHAK 25C, Ch 2, The Decision-Making Process (5P Check)

## THE DECISION-MAKING PROCESS

**SOURCE** PHAK 25C, Ch 2, The Decision-Making Process

Some situations, like an engine failure, demand an immediate, memorized response. Most do not. Usually you have time to detect that something changed, gather information, and assess risk before acting. The FAA gives you structured tools so the analysis actually happens. The 3P model is the continuous loop: Perceive the hazards, Process their impact on flight safety, and Perform the best course of action. You perceive with the PAVE checklist: Pilot, Aircraft, enVironment, and External pressures. You process with CARE, and you choose risk controls with TEAM.

The 5P check is Plan, Plane, Pilot, Passengers, and Programming. It applies the same discipline at key decision points: preflight, before takeoff, at the midpoint of the flight, before descent, and before entering the pattern. The easiest place to cancel a flight is the first of those points, not the last.

The DECIDE model, quoted below, expands the same idea into six steps for a developing problem. The first step is where most errors live: detecting the problem correctly. The same open door is a nuisance in VFR conditions and a genuine workload problem in the clouds. So estimating the need to react depends on the situation, not just the malfunction. When time is short, experienced pilots use automatic decision-making. They recognize the situation as familiar and take the first workable option, rather than comparing every alternative. That skill is built from training and experience. That is what this review flight is for.

One more idea worth keeping: failure to make a decision is a decision. A pilot who says the flight will probably be okay is due for a reality check.

> *"DECIDE means to Detect, Estimate, Choose a course of action, Identify solutions, Do the necessary actions, and Evaluate the effects of the actions."*

PHAK 25C, Ch 2, The DECIDE Model

## SITUATIONAL AWARENESS AND WORKLOAD

**SOURCE** PHAK 25C, Ch 2, Situational Awareness + Workload Management

Situational awareness is more than knowing where you are. The definition below spans all five risk elements, before, during, and after the flight. It demands knowing why things are happening, not just what. A pilot who holds the overall picture does not fixate on one factor that seems significant while the rest of the flight deteriorates. Monitor radio communications for traffic, weather discussion, and ATC activity. That simple habit keeps your mental picture current.

The obstacles are predictable. Fatigue, stress, and work overload cause fixation on a single item. They shrink your awareness of everything else. Many accidents trace to a distraction that began as a minor problem, while the pilot neglected basic aircraft control. The countermeasure is workload management. Prepare for high-workload phases during low-workload phases: get frequencies and checklists done early, and listen ahead on ATIS or CTAF. Recognize overload by its first symptom: working harder while accomplishing less. Answer it by stopping, thinking, slowing down, and prioritizing. Flying the airplane always comes first.

> *“Situational awareness is the accurate perception and understanding of all the factors and conditions within the five fundamental risk elements (flight, pilot, aircraft, environment, and type of operation that comprise any given aviation situation) that affect safety before, during, and after the flight.”*

PHAK 25C, Ch 2, Situational Awareness

> *“Fatigue, stress, and work overload can cause a pilot to fixate on a single perceived important item and reduce an overall situational awareness of the flight.”*

PHAK 25C, Ch 2, Obstacles to Maintaining Situational Awareness

## COMMON ERRORS REVIEW: SLOW FLIGHT AND STALLS

**SOURCE** AFH 3C, Ch 5, Common Errors (Slow Flight + Intentional Stalls)

Before the review flight, self-brief against the FAA's own error lists. In slow flight, the same errors keep coming back. Pilots fail to clear the area. They mismanage the elevator as power is reduced. They use too little right rudder and fixate on the instruments. They do not anticipate angle of attack changes as the flaps move. They manage power poorly, trim poorly, and fail to respond to a stall warning.

In stalls, the error list is really one lesson repeated: angle of attack comes first. Pilots get in trouble when they try to level the wings before reducing angle of attack. They add power before reducing angle of attack. They relax the nose-down input before the stall warning is gone. Or they haul back too soon and trigger a secondary stall. The other classics: failing to recognize the impending stall, losing rudder coordination through the stall and recovery, and using so much forward elevator that the airplane unloads into low or negative G. Fly this review with those specific traps in mind. Grade yourself against them.

# COMMON ERRORS REVIEW: GROUND REFERENCE, GO-AROUNDS, AND EMERGENCIES

**SOURCE** AFH 3C, Ch 7, Rectangular Course + S-Turns Common Errors + Ch 9, Go-Arounds Common Errors + Ch 18, Emergency Landings

The ground reference error lists from the rectangular course and S-turns repeat the same failures. Pilots do not clear the area for hazards at the start and throughout. They do not establish and hold altitude. They misread the wind direction and miss the wind correction angle. They fly uncoordinated aileron and rudder, which produces slips and skids. They make rough control movements, divide their attention poorly, and time their turns badly. Every one of them is an attention error before it is a stick-and-rudder error.

For go-arounds, the list starts before the controls move: failure to recognize a condition that warrants rejecting the landing, indecision, and delay. Then come the mechanical errors: late or abrupt power, improper pitch attitude, the wrong configuration sequence, climbing out of ground effect too soon, and inadequate compensation for torque and P-factor.

For the emergency procedures portion, remember the mindset from Chapter 18. Accept the situation promptly. Fly the airplane first. Put it down under control at the lowest possible controllable airspeed. Bring the emergency checklist for this airplane and know where your hands go first. The POH procedures govern.

**LESSON 6 · MANEUVER REVIEW AND EMERGENCY PROCEDURES**

# *REVIEW QUESTIONS*

*Answer in writing before your preflight briefing. Key at the back of this volume.*

1. What are the three steps of the 3P model, and what checklist goes with the first step?
2. What does DECIDE stand for?
3. Define situational awareness.
4. What is the first symptom of work overload, and what do you do about it?
5. In a stall recovery, what must happen before you level the wings or add power?
6. Name the two decision errors that head the go-around common errors list.

**LESSON 7** · **PAIRS WITH GROUND MODULE 6**

# *Takeoffs and Landings, Steep Turns, Stalls*

*Lesson 7 is concentrated pattern work. You will fly repeated takeoffs and landings with a go-around available off every approach, and you will meet steep turns and accelerated stalls. By the end of this flight, you should be making directed takeoffs and landings without help on the controls. This chapter gives you the takeoff, traffic pattern, and landing procedures from the Airplane Flying Handbook. It adds the collision avoidance scan from AC 90-48E, plus the aerodynamics behind steep turns and accelerated stalls.*

**MEMORY AID** · **FAA**

### 10 Degrees, 1 Second

*The scan rhythm that gives your eyes a real chance to detect traffic.*

Move your eyes in short, regularly spaced steps of no more than 10 degrees.
Watch each block of sky for at least 1 second.
Move your head, not just your eyes, to clear the windshield posts.
Remember the clock: the full see, recognize, and react chain takes about 12.5 seconds.

AC 90-48E, para 12, Effective Scanning Techniques

## PRIOR TO TAKEOFF

**SOURCE** AFH FAA-H-8083-3C, Ch 6, Prior to Takeoff

Takeoff is short but hazard dense: about twenty percent of all yearly general aviation accidents occur during takeoff and departure climbs. More than half come from some failure of the pilot. Before going to the airplane, check the POH performance charts and decide whether a safe takeoff and climb is possible for the conditions and location. High density altitude means the air is thin. It reduces engine and propeller performance, increases takeoff rolls, and decreases climb performance.

Complete all run-up and pre-takeoff checklist items before taxiing onto the runway. As a minimum, check the engine instruments for proper indications, and check all controls for full, free, and correct movement. Decide your options for an engine failure after takeoff, including the preferred direction for an emergency turn. Make certain the approach and takeoff paths are clear by announcing on the CTAF or receiving a takeoff clearance from the tower. Avoid taking off immediately behind a large, heavy airplane, because of wake turbulence. Pick ground references aligned with the runway to hold alignment through the climb out.

## NORMAL TAKEOFF AND INITIAL CLIMB

**SOURCE** AFH FAA-H-8083-3C, Ch 6, Normal Takeoff

Take off as nearly into the wind as possible. A headwind gives you airspeed before you begin accelerating, and it lowers the ground speed needed to reach flying speed, which shortens the roll. Steer the nose-wheel onto the centerline, then advance the throttle smoothly and continuously to takeoff power. Abrupt power can yaw the airplane sharply left from torque. Keep your feet on the rudders, not the brakes, and check the engine instruments. Use rudder against torque and P-factor, and hold aileron into any crosswind. Look far down the runway at two aligned points. Outside references, not the instruments, tell you how the airplane is responding.

As the controls become effective, apply gradual back-elevator pressure to raise the nose-wheel slightly. This rotation establishes the lift-off attitude. Do not force the airplane off, because excessive angle of attack can make it settle back or stall. In strong, gusty wind, stay on the ground slightly longer for an extra margin of speed, then rotate smoothly and positively.

After lift-off, hold the pitch attitude for VY, the best rate of climb speed. Once a positive rate of climb is established, retract flaps and gear if equipped, and keep takeoff power until at least 500 feet above the surrounding terrain or obstacles. VY plus takeoff power buys the most altitude in the least time. Control airspeed with small pitch changes referenced to the natural horizon, and keep the climb path aligned with the runway.

# CROSSWIND TAKEOFF AND GROUND EFFECT

**SOURCE** AFH FAA-H-8083-3C, Ch 6, Crosswind Takeoff + Ground Effect on Takeoff

Begin the takeoff roll with full aileron into the crosswind, which keeps the upwind wing from rising. Relax the input as the ailerons become effective. Use rudder, typically downwind rudder, to stop the airplane from weathervaning into the wind. If the upwind wing rises, more surface is exposed to the wind, and the airplane can skip sideways in small bounces that impose severe side stresses on the landing gear. Hold enough aileron that the airplane sideslips into the wind just enough to counter drift immediately after lift-off.

With a significant crosswind, hold the main wheels on slightly longer than normal, then make a smooth but very definite lift-off. The downwind wheel lifting first is preferable to side-skipping. Once climbing, transition from sideslip to crab: point the nose into the wind, level the wings, and keep the ground track over the runway centerline extension. Check drift often, because the wind can change markedly within a few hundred feet of the ground.

Ground effect is improved performance very close to the ground, normally up to a height of about one wingspan. Reduced wingtip vortices cut induced drag about 25 percent at a height of one quarter the span, and about 50 percent at one tenth. Here is the trap: the airplane may seem able to lift off below the recommended airspeed, then be unable to climb out of ground effect. That risk grows at high density altitude, high temperature, or maximum gross weight. Lift off at the recommended speed for adequate initial climb performance.

# THE AIRPORT TRAFFIC PATTERN

**SOURCE** AFH FAA-H-8083-3C, Ch 8, Airport Traffic Patterns

Traffic patterns keep traffic moving into and out of an airport safely. Make all pattern turns to the left, unless approved visual markings indicate right turns. Pattern altitude is usually 1,000 feet above the airport elevation, and where no tower operates, that common altitude is the key factor in minimizing collision risk. No pattern, service, or procedure ever diminishes your responsibility to see and avoid other aircraft, from ramp-out to ramp-in.

Departure: fly straight out from lift-off. Staying in the pattern, turn crosswind beyond the departure end, within 300 feet of pattern altitude. Leaving, continue straight out, or exit at 45 degrees after reaching pattern altitude. Crosswind: fly perpendicular to the runway extension, angled into the wind to hold the ground track. Downwind: fly parallel and opposite the landing direction, one half to one mile out. Complete the before-landing checks and hold altitude until at least abeam the approach end, then reduce power, descend, and turn base about 45 degrees past the approach end. Base: position for a gradual descent, with the ground track perpendicular to the centerline and drift correction in. Final: verify you are lined up with the correct runway, not a taxiway or road. Before turning final, confirm no one is established on final. The lower aircraft has the right-of-way, but no one may use that rule to cut in front of or overtake another. If the turn to final would create a collision hazard, go around.

At a nontowered airport, always enter at pattern altitude, preferably on a 45 degree angle to the downwind at midfield. Arriving from the upwind side, announce and cross midfield at least 500 feet above pattern altitude, or 2,000 feet AGL where large or turbine aircraft operate. Fly about 2 miles clear, then descend and return on the 45. The alternate midfield crosswind entry is not for busy patterns. Typical piston singles fly 70 to 90 knots on downwind. Per the NTSB, the most probable cause of midair collisions is failing to see and avoid. Most occur at or near uncontrolled airports, below 1,000 feet, between aircraft going the same direction, and most reported midairs happen on final or short final.

# SEE AND AVOID: YOUR EYES AND YOUR SCAN

**SOURCE** AC 90-48E, Pilots' Role in Collision Avoidance + 14 CFR 91.113(b)

See and avoid is a regulatory obligation, VFR or IFR alike, and AC 90-48E exists to help you meet it. Your eyes have hard limits: refocusing from the panel to an aircraft a mile away takes 1 to 2 seconds. The FAA's reaction time chart totals 12.5 seconds from seeing an object to the airplane actually moving out of the way. The eye can focus on and classify an object only within about 10 to 15 degrees, so you tend to disbelieve motion caught in your peripheral vision. Two converging aircraft appear virtually motionless to each other, until one suddenly blooms into a huge mass in the window. Haze, glare, and empty-field myopia make everything worse. Empty-field myopia means your eyes relax to a near focus when the sky looks blank. So move your head, not just your eyes, around windshield posts.

In a climb, adjust pitch to see over the nose. In cruise or descent, make gentle shallow bank turns to clear ahead and to the sides, and occasionally check behind. In the pattern, keep scanning and clear your airframe's blind spots. High wings restrict visibility above and low wings restrict it below, so the worst case is a low-wing airplane flying above a high-wing airplane. Traffic advisories and cockpit displays never relieve the see-and-avoid responsibility.

> *“When weather conditions permit, regardless of whether an operation is conducted under instrument flight rules or visual flight rules, vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft.”*

14 CFR 91.113(b)

> *“Effective scanning is accomplished with a series of short, regularly spaced eye movements that bring successive areas of the sky into the central visual field. Each movement should not exceed 10 degrees, and each area should be observed for at least 1 second to enable detection.”*

AC 90-48E, para 12, Effective Scanning Techniques

**GROUND MODULE 6 · TRAFFIC PATTERNS, COLLISION AVOIDANCE, AND WAKE TURBULENCE**

# WAKE TURBULENCE IN THE PATTERN

**SOURCE** North Aero Ground Module 6 (Traffic Patterns) + AIM Ch 7, Section 4, Wake Turbulence

Every aircraft generates wake turbulence in flight, because lift is the cause. The pressure difference across the wing rolls the airflow up behind the wingtips into two counter-rotating vortices that trail behind the airplane. Most of the energy is concentrated within a few feet of each core. The wake begins when an airplane rotates for takeoff and ends at its touchdown point, and that detail drives every avoidance procedure. The vortices are invisible, and they can impose rolling moments that exceed your ailerons' authority. Short wingspans have the hardest time countering the roll, and a trainer is a short wingspan.

Strength is set by the weight, speed, wingspan, and wing shape of the generating aircraft. Vortex strength grows with more weight and with less speed, and a dirty configuration actually hastens wake decay. So the greatest vortex strength comes from an airplane that is heavy, clean, and slow. That describes a large airplane right after rotation or on approach. The vortices sink at several hundred feet per minute, weakening with time and distance, and within 100 to 200 feet of the ground they spread laterally at 2 or 3 knots. Wind changes the picture. A crosswind of 1 to 5 knots can hold the upwind vortex in the touchdown zone, and a tailwind can push the vortices forward into the touchdown zone. The AIM prints its warning in capital letters: the light quartering tailwind requires maximum caution.

The procedures all flow from one idea: stay at or above the other airplane's flight path, and touch down beyond where its wake stopped. Landing behind a larger aircraft on the same runway, stay at or above its final approach path, note its touchdown point, and land beyond it. Landing behind a departing larger aircraft, note its rotation point and land well before that point. Departing behind a larger aircraft, rotate before its rotation point, then climb above its climb path until you turn clear, and avoid headings that cross below and behind it. After a larger airplane makes a low approach, missed approach, or touch-and-go, let at least 2 minutes pass before your takeoff or landing. Know the legal hook, too. When a controller issues traffic, tells you to follow an aircraft, or you accept a visual approach clearance, you have accepted responsibility for wake turbulence separation.

Your ground module anchors this with the Kansas City Saratoga accident of June 12, 2006. A Piper Saratoga flew a visual approach to runway 01R while a Boeing 737 landed on parallel runway 01L. The Saratoga crossed the 737's flight path twice. The second crossing was 600 feet below where the 737 had passed about two minutes earlier, directly in the descending vortex core. Both sides of the stabilator and the left wing separated in flight. The NTSB's probable cause pointed at speed: the Saratoga exceeded maneuvering speed at the encounter. At or below VA, a vortex encounter is a violent upset you can recover from. Above VA, the same encounter can break the airplane. You already fly VA for steep turns and stalls. Fly it near wakes too.

> *“Since the turbulence from a “dirty” aircraft configuration hastens wake decay, the greatest vortex strength occurs when the generating aircraft is HEAVY, CLEAN, and SLOW.”*
>
> AIM 7-4-3

> *“Pilots should fly at or above the preceding aircraft's flight path, altering course as necessary to avoid the area directly behind and below the generating aircraft.”*
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> AIM 7-4-4

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## BASE, FINAL, AND THE STABILIZED APPROACH

**SOURCE** AFH FAA-H-8083-3C, Ch 9, Normal Approach and Landing + Stabilized Approach Concept

Base placement sets up the landing. With a strong wind on final or steep flap settings, position base closer to the approach end. Descend on base with reduced power at about 1.4 VSO, and hold off on full flaps until you are established on final. The AFH does not recommend full flaps until the final approach is established. On final, align the longitudinal axis with the centerline and set the final flaps. Fly the manufacturer's recommended approach speed, or 1.3 VSO if there is none, and land in the center of the first third of the runway. Pitch and power work together: if you are too high, lower the nose and reduce power, and if you are too low, add power and raise the nose. Never stretch a final with back-elevator alone, because pitch alone drives angle of attack up and airspeed down, toward an excessive sink rate or a low altitude stall.

The aiming point is the one spot that does not appear to move in the windshield. The runway's shape confirms the glide path. Stabilized, it keeps the same trapezoidal shape, only larger. Going shallow, it appears to shorten and widen, and steepening, it appears longer and narrower.

For a typical piston airplane, the criteria are these: a constant glide path, typically 3 degrees, to the touchdown zone, and centerline tracking, with bank normally limited to 15 degrees once established. Airspeed within plus 10 or minus 5 knots of the recommended landing speed. Landing configuration set, the airplane in trim, and a descent rate generally of 500 to 1,000 fpm. If approach considerations force a descent rate over 500 fpm, reduce it before 300 feet AGL. Power no lower than the AFM minimum, with briefings and checklists complete. Pilots typically go around if not stabilized by 500 feet above airport elevation in VMC. An approach that becomes unstabilized below 300 feet AGL warrants an immediate go-around. Never retract flaps to fix an undershoot, because the sudden loss of lift aggravates the unstable condition.

> *“A stabilized approach is one in which the pilot establishes and maintains a constant-angle glide path towards a predetermined point on the landing runway. It is based on the pilot’s judgment of certain visual clues and depends on maintaining a constant final descent airspeed and configuration.”*

AFH FAA-H-8083-3C, Ch 9, Stabilized Approach Concept

# ROUND OUT, AND WHAT GOES WRONG IN THE FLARE

**SOURCE** AFH FAA-H-8083-3C, Ch 9, Round Out (Flare) + Faulty Approaches and Landings

The round out, or flare, is a slow, smooth transition from approach attitude to landing attitude. It bends the flightpath parallel to, and a few inches above, the runway. Start at 10 to 20 feet in a normal descent, applying back-elevator gradually so the airplane keeps settling slowly as speed decreases. Done right, landing attitude and touchdown speed arrive together as the wheels touch. Started high, flare more slowly. With full flaps, the nose travels through a greater pitch change, so raise it faster. Once the round out begins, never push the elevator forward, only relax or hold the pressure, and add a little power if the sink becomes excessive. Keep one hand on the throttle throughout.

Faulty approaches first. On a low final, apply power immediately while raising the pitch attitude. Never pitch up without power, and never retract flaps to fix it. On a high final, lower flaps as required, reduce power and lower the nose, or use a forward slip. A sink rate beyond 800 to 1,000 fpm is excessive, so do not dive at the runway. On a slow final, add power while altitude remains, and if you are too slow and too low, go around.

Now faulty flares. If you round out high, hold the attitude until the airplane settles again, and go around if the nose ever needs lowering close to the runway. A late or rapid round out can trigger an accelerated stall just above the runway, so recover with prompt power. Floating means excess approach speed, and ballooning means the flare made the airplane climb. Go around if you cannot land in the first third, the airplane drifts, or the balloon is excessive. A slight bounce can be cushioned with power and repitched. A severe bounce or porpoise is an immediate go-around: full power, directional control, nose to a safe climb attitude. Never touch down drifting or crabbed, because side loads can fail the gear and start a ground loop. When the landing is in doubt, go around.

# STEEP TURNS AND ACCELERATED STALLS

**SOURCE** AFH FAA-H-8083-3C, Ch 10, Steep Turns + Ch 5, Accelerated Stalls

Steep turns are 360 or 720 degree turns at 45 to 60 degrees of bank. You fly them to develop control smoothness, coordination, division of attention, and a constant traffic scan. Load factor is the load the wings carry compared with the airplane's weight. In a level 45 degree bank the load factor is 1.41, and at 60 degrees it is 2.0, doubling the airplane's effective weight. Standard category airplanes are designed for a load factor of 3.8, and a level 75 degree bank exceeds that limit. Stall speed rises with the square root of the load factor, so a 50 knot level stall becomes 60 knots at 45 degrees of bank and 70 knots at 60. Fly the maneuver at or below maneuvering speed, VA, or operating maneuvering speed, VO. At those speeds, the airplane stalls before the design load limit can be exceeded. Expect the overbanking tendency to require deliberate opposite aileron.

Flying it: clear the area, pick distant rollout references, and set the entry speed. Roll smoothly to the target bank, adding smooth back-elevator pressure and power, generally before 30 degrees of bank. Watch the nose and the wings against the horizon together, because the nose alone will not hold your altitude. Fix a nose-low deviation by shallowing the bank first, with coordinated aileron and rudder, then raising the pitch. Pulling with elevator alone steepens the bank and stresses the airplane. Lead the rollout by about half the bank angle, removing any added power and trim as you finish.

An accelerated stall is any stall above positive 1G. Load the wing in a turn, a pull-up, or an abrupt flightpath change, and the stall arrives at a higher indicated airspeed than the familiar 1G number. It happens most often during improperly executed turns, pullouts from steep dives, or a base-to-final overshoot. Demonstrations use about 45 degrees of bank. Never fly them with flaps extended, because flaps lower the design G-load limit, and never fly them above the recommended speed, VA, or VO. Coordinated, the airplane stalls much as it does wings level, with a sharper buffet. Uncoordinated, the bank may change until the angle of attack is reduced. Recover at the first indication: apply forward elevator to reduce the angle of attack and eliminate the stall warning. Level the wings with ailerons, coordinate with rudder, and adjust power. Accelerated stalls are more aggressive than 1G stalls, and they arrive at unexpected speeds and attitudes. A delayed recovery can become a spin or another departure from controlled flight.

LESSON 7 · TAKEOFFS AND LANDINGS, STEEP TURNS, STALLS

# REVIEW QUESTIONS

*Answer in writing before your preflight briefing. Key at the back of this volume.*

1. What approach speeds does the AFH give for the base leg and final approach?
2. Define a stabilized approach in the AFH's terms.
3. You are low and slow on final. What is the correct fix, and what two fixes are wrong?
4. At what height does the round out begin, and what is the technique?
5. The airplane bounces hard on touchdown. What do you do?
6. What are the load factors in level 45 and 60 degree banked turns, and what happens to stall speed?
7. Why are steep turns and accelerated stalls flown at or below VA or VO?
8. What does 14 CFR 91.113(b) require of you in the pattern?
9. Describe an effective visual scan and why small eye movements matter.
10. How do you enter the pattern at a nontowered airport when arriving from the upwind side?
11. When does an airplane generate wake vortices, and when are they strongest?
12. You are landing behind a large airplane that just departed your runway. Where is its wake, and where do you land?
13. Why does the AIM single out the light quartering tailwind?
14. What did the Kansas City Saratoga accident show about maneuvering speed and wakes?

**LESSON 8** · **PAIRS WITH GROUND MODULE 8**

# *Crosswind, Slips, Soft Field, Go-Arounds*

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*Lesson 8 adds crosswind takeoffs and landings, introduces slips, and starts you on soft-field technique, with go-arounds practiced from multiple scenarios. You should now be making unassisted takeoffs and landings and flying an accurate pattern. This chapter covers the two crosswind landing methods and how to know when the wind exceeds the airplane. It also covers the difference between a forward slip and a sideslip, plus soft-field technique. The sources are the Airplane Flying Handbook and the Pilot's Handbook of Aeronautical Knowledge.*

**MEMORY AID** · **FAA**

## Wing-Low Crosswind Cue

*How the two controls divide the work in a crosswind landing, from final all the way through rollout.*

Rudder holds the nose: use it to keep the longitudinal axis aligned with the runway.

Aileron stops the drift: lower the upwind wing just enough to cancel the sideways movement.

Keep adjusting both through round out, touchdown, and rollout, adding more deflection as the controls lose effectiveness.

The limit: if full opposite rudder cannot keep the airplane from turning, the wind is too strong for that runway.

AFH FAA-H-8083-3C, Ch 9, Crosswind Approach and Landing

**MEMORY AID** · **FAA**

## Red Means Stop, Yellow Means Info

*The airport sign color code, straight from the ground module.*

White on red: mandatory. A runway entrance or a prohibited area. Get a clearance before you pass it.

Yellow on black: location. It names the taxiway or runway you are on.

Black on yellow with an arrow: direction or destination. It points the way.

The module's one-liner: red always means stop or get a clearance first. Yellow means information.

North Aero Ground Module 8 + AIM 2-3-8 through 2-3-11

**MEMORY AID** · **FAA**

### Two Red, Two White

*How to read the PAPI and VASI at a glance.*

PAPI, four lights in a row: two white and two red means on glidepath, about 3 degrees.

More white, you are high. Four white is above 3.5 degrees.

More red, you are low. Four red is below 2.5 degrees.

Two-bar VASI: red over white is on the glide path. All white is high, all red is low.

PHAK 25C, Ch 14, Figures 14-29 and 14-30 + AIM 2-1-2

**MEMORY AID** · **FAA**

### 7-5-3 Clicks

*The pilot-controlled lighting sequence.*

Key the mike on the published frequency: 7 clicks within 5 seconds for full intensity.

5 clicks for medium, 3 for low. On some systems, 5 or 3 also lowers or turns off the REIL.

Always start with 7, then step down.

You get 15 minutes per activation. Key again on the way in for a fresh 15.

AIM 2-1-8, Pilot Control of Airport Lighting

**MEMORY AID** · **NORTH AERO TEACHING AID**

### Climb Into, Dive Away

*Control positions for taxiing in wind, in one line.*

Quartering headwind: stick INTO the wind. Upwind aileron up. Elevator: neutral in the Warrior, full back in the tailwheel airplanes.

Quartering tailwind: stick AWAY from the wind and FORWARD. Upwind aileron down, elevator down, in both gear types.

Tailwheel fine print: a light tailwind plus prop wash can favor back stick. Sample the wind.

*Technique per AFH Chapter 2 (tricycle) and Chapter 14 (tailwheel).*

## SOFT AND ROUGH-FIELD TAKEOFF AND CLIMB

**SOURCE** AFH FAA-H-8083-3C, Ch 6, Soft/Rough-Field Takeoff and Climb

Soft-field technique gets the airplane airborne as quickly as possible, which eliminates the drag of tall grass, soft sand, mud, and snow. The same technique protects the gear on a rough field. The core idea is to transfer the airplane's weight from the wheels to the wings as rapidly as possible. Do that by establishing a nose-high pitch attitude, a relatively high angle of attack, as early as possible. Lower the flaps before starting if the manufacturer recommends it.

Keep the airplane moving with sufficient power while lining up, because stopping on mud or snow might bog it down.

On the roll, apply takeoff power smoothly, and as rapidly as the powerplant can accept it without faltering. Hold enough back-elevator pressure to establish a positive angle of attack and unload the nose-wheel. Held nose-high, the wings take more and more of the airplane's weight as lift develops, which minimizes drag from surface irregularities or adhesion. Flown accurately, the airplane virtually flies itself off the ground, but it becomes airborne below a safe climb speed because of ground effect.

That is the critical moment. After lift-off, gently lower the nose with the wheels clear of the surface, and let the airplane accelerate. While transitioning out of ground effect, the airplane will tend to settle back onto the surface even with full power applied. So it is essential to remain in ground effect until at least VX. After a positive rate of climb is established and the airplane accelerates to VY, retract gear and flaps if equipped. With an obstacle ahead, climb at VX until it is cleared, then VY. The common errors: too little back-elevator on the roll, and climbing too high after lift-off instead of leveling low in ground effect. Add letting the airplane mush back on, and climbing out of ground effect before reaching sufficient climb speed.

## CROSSWIND APPROACH: CRAB AND WING-LOW

**SOURCE** AFH FAA-H-8083-3C, Ch 9, Crosswind Approach and Landing

Most landings happen with wind at some angle to the runway, so every pilot needs a working crosswind method. There are two: the crab method and the wing-low (sideslip) method. The AFH recommends wing-low in most cases. A combination may be used, and testing standards allow either, so learn both. Crosswind landings are a little harder than crosswind takeoffs, because control effectiveness is decreasing as you slow rather than increasing as you accelerate.

In the crab method, a coordinated turn establishes a heading into the wind that keeps the wings-level ground track on the centerline. Hold the crab until just prior to touchdown. Then use rudder to align the longitudinal axis with the runway. The crab is easy to fly down final, but it demands judgment and precise timing. Remove the crab too early or too late, and the airplane touches down with a side load. On a long final, a good option is to crab at first, then transition smoothly to wing-low before the round out.

In the wing-low method, first use rudder to align the airplane's heading with the runway. The airplane starts to drift, so note the rate and direction, then lower the upwind wing just enough with aileron to cancel the drift. Bank controls the sideways movement. Rudder keeps the longitudinal axis aligned, and both are adjusted continuously to hold the centerline. Ground track and longitudinal axis stay aligned with the runway through final, round out, touchdown, and rollout, which protects the landing gear from side loads. Landing while holding a bank feels odd at first, but the upwind wingtip is not going to strike the ground.

The stronger the crosswind, the lower the upwind wing must go, and the more opposite rudder it takes to keep the airplane from turning. That is the built-in limit. If the required bank is such that full opposite rudder does not prevent a turn, the wind is too strong to safely land on that runway. Make the landing on a more favorable runway there, or at an alternate airport. Flaps are used on most approaches for their stabilizing effect, with the amount varied for handling characteristics and wind velocity.

## CROSSWIND ROUND OUT, TOUCHDOWN, AND ROLLOUT

**SOURCE** AFH FAA-H-8083-3C, Ch 9, Crosswind Approach and Landing

Fly the crosswind round out like a normal one, except the drift correction continues all the way through. As airspeed decays in the flare, the controls lose effectiveness and the same correction becomes inadequate. So gradually increase rudder and aileron deflection to keep the drift canceled, and keep the upwind wing down throughout. Level the wings, and the airplane immediately starts drifting. The whole objective is a touchdown without side load.

If you crabbed all the way down, remove the crab the instant before touchdown with rudder. With wing-low, simply maintain the correction. The initial touchdown occurs on the upwind main wheel, and the downwind main settles as momentum decreases. In gusty or high wind, make prompt adjustments so the airplane does not drift as it touches. Some airplanes have nose-wheel steering interconnected with the rudder. In those, relax the corrective rudder pressure as the nose-wheel touches down, or the offset nose-wheel will swerve the airplane.

The rollout is where the crosswind keeps working on you. The airplane has more side area behind the main gear than ahead of it, so it tends to weathervane. That means it tries to swing its nose into the wind. As ground speed decreases, the relative wind lines up more and more with the crosswind component, so the tendency grows as you slow. Maintain direction with rudder or nose-wheel steering. Keep the upwind wing from rising with aileron. The ailerons lose effectiveness as you decelerate, while the crosswind gains leverage. So keep feeding in more aileron, and hold the control fully toward the wind as the airplane stops. Tire side loads from drifting can even lift a main wheel and tip a tricycle-gear airplane toward a roll-over. Ailerons, rudder, or steering can prevent that, but brakes cannot. The common errors: landing in wind that exceeds the maximum demonstrated crosswind component, touching down drifting or misaligned, abandoning the controls on rollout, and excessive braking.

## HOW MUCH CROSSWIND IS TOO MUCH

**SOURCE** AFH FAA-H-8083-3C, Ch 9, Maximum Safe Crosswind Velocities + PHAK 25C, Ch 11, Crosswind and Headwind Component Chart

Takeoffs and landings in certain crosswind conditions are inadvisable, or even dangerous, so weigh the reported surface wind against the available landing directions before you commit. Before type certification, every airplane is flight tested for crosswind control. It must be satisfactorily controllable, with no exceptional degree of pilot skill or alertness, in 90 degree crosswinds up to a velocity of 0.2 VSO. That is two-tenths of the stalling speed with power off in landing configuration. The PHAK gives the scale: an airplane that stalls at 45 knots must be capable of landing in a 9 knot direct crosswind. The demonstrated crosswind velocity is placarded in airplanes certificated after May 3, 1962, and it is published in the AFM/POH. Determine that number for every airplane you fly. Avoid wind conditions that exceed its capability.

The crosswind and headwind component chart turns a reported wind into the two numbers you use. The headwind component is for performance, and the crosswind component is for controllability. First find the wind angle, the difference between runway heading and wind direction. Take the PHAK's sample problem: runway 17, with wind from 140 degrees at 25 knots. That gives a 30 degree wind angle. Follow the 30 degree line to the 25 knot velocity arc, then read straight down and straight across: 22 knots of headwind and 13 knots of crosswind. Use the chart to pick the best runway when more than one exists, and to keep the airplane inside its tested limits.

## SLIPS: SIDESLIP VERSUS FORWARD SLIP

**SOURCE** AFH FAA-H-8083-3C, Ch 9, Intentional Slips

A slip occurs when the bank angle is too steep for the existing rate of turn. Unintentional slips come from uncoordinated rudder and aileron. Intentional slips are a tool. Use them to dissipate altitude without increasing airspeed, and to adjust the ground track in a crosswind. Use them to descend rapidly in forced landings, over obstacles into confined areas, or when flaps are inoperative or not installed. A slipping airplane is actually flying somewhat sideways, which markedly increases drag. And because the airplane is banked, the vertical component of lift is reduced, so it descends rapidly with no increase in airspeed. Most airplanes naturally resist slipping, so an intentional slip requires deliberate cross-controlling of aileron and rudder throughout.

There are two types, and what separates them is what the airplane's path over the ground does. Enter a sideslip by lowering a wing and applying just enough opposite rudder to prevent a turn. The nose stays pointed straight down the runway, while the airplane moves somewhat sideways toward the low wing. That is the crosswind landing tool. In a forward slip, the wing is lowered and enough opposite rudder is applied to yaw the nose the other way. The airplane keeps flying its original path over the ground, with the nose pointed off to the side. Bank angle sets the amount of slip, and in a forward slip, the steeper the bank, the steeper the descent. Power is normally at idle in a forward slip. Control airspeed with the elevator. With a crosswind present, slip into the wind by lowering the upwind wing.

In most light airplanes, available rudder travel limits how steep a slip can get. The practical slip limit is the point where full rudder is required to maintain heading, even though the ailerons could steepen the bank further. To end a slip, level the wings and release the rudder pressure at the same time, while readjusting to the normal glide attitude. Release the rudder abruptly, and the nose swings quickly into line while the airplane builds excess speed. Two cautions. Because of pitot and static port placement, airspeed indicators in some airplanes read with considerable error in a slip. So recognize a proper slip by the attitude, the sound of the airflow, and the control feel. And some airplanes carry slip limitations on duration, fuel quantity, or flap position, so consult the AFM/POH. A slip also differs from a skid in a stall. An airplane stalled from a slip shows very little of the yawing tendency that turns a skidding stall into a spin. It may do little more than roll toward wings level.

> *“In a sideslip, the airplane’s longitudinal axis remains parallel to the original flightpath, but the airplane no longer flies straight ahead.”*
>
> AFH FAA-H-8083-3C, Ch 9, Intentional Slips

> *“A forward slip is used to dissipate altitude and increase descent rate without increasing airspeed. In a forward slip, the airplane’s direction of motion continues the same as before the slip was begun.”*
>
> AFH FAA-H-8083-3C, Ch 9, Intentional Slips

## FORWARD SLIP TO A LANDING

**SOURCE** AFH FAA-H-8083-3C, Ch 9, Forward Slip to a Landing

The forward slip to a landing is flown as a complete pattern maneuver. It earns its place in the Private Pilot ACS for a practical reason. In a real engine failure, the slip gives you options flaps cannot. You can establish it faster than flaps deploy, and you can remove it without penalty to shallow the descent. Retracting flaps on an approach, by contrast, can cost altitude you do not have.

The profile: plan the descent so a forward slip can be used on final, with flaps usually remaining retracted. Abeam the landing point on downwind, reduce power to idle, and slip on downwind if the descent rate is insufficient. Make a coordinated turn to base, and keep evaluating height. Continue the slip on base if still high, then make a coordinated turn onto final. Established on final with sufficient height, use the forward slip to set the approach path to the aiming point. As the round out begins, remove the slip and transition to a normal landing.

Memorize the common errors before you fly it. They are poor airspeed control, reacting to erroneous airspeed indications, and carrying excess power while trying to lose altitude. Add slipping in the same direction as the crosswind instead of into it, a late transition to the sideslip in a crosswind, and touching down misaligned or off the centerline.

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## SOFT-FIELD APPROACH AND LANDING

**SOURCE** AFH FAA-H-8083-3C, Ch 9, Soft-Field Approach and Landing

Landing on rough or soft surfaces, such as snow, sand, mud, or tall grass, has one objective: touch down as smoothly as possible, at the slowest possible landing speed. Let the wings support the airplane's weight as long as practical, which minimizes gear stress on a rough surface and keeps the airplane from sinking into a soft one.

The approach resembles a normal approach into a long, firm field. Fly it at the same final approach speed used for short-field landings, because higher speeds cause excessive float in ground effect. There is no reason for a steep descent unless obstacles are in the path. The major difference from a normal landing: carry a degree of power through the level-off and touchdown. Let airspeed dissipate slowly while you fly the airplane 1 to 2 feet off the surface in ground effect. Flaps aid a minimum-speed touchdown and are recommended whenever practical. On low-wing airplanes, though, the wheels can throw mud, stones, or slush that damages the flaps. Either way, do not retract them during the rollout. Total concentration on controlling the airplane matters more.

Touch down at the lowest possible airspeed, in a nose-high pitch attitude, with the wings still carrying much of the weight. After the mains touch, hold back-elevator to keep the nose-wheel off the surface. Use elevator and engine power together to control how fast weight transfers from wings to wheels. Conditions may warrant keeping the mains just touching, wings still supporting the airplane, until you reach a firmer surface. Until the weight is on the wheels and the nose-wheel is down, you can still apply full power and take off if you elect to abandon the landing. That assumes obstacles and field length permit it. Once committed, gently lower the nose-wheel, using a slight power addition to ease it down. Do not use the brakes, because braking loads the nose gear and can dig the nose-wheel in. The surface itself decelerates you, and on a very soft field you may need added power just to keep moving. The common errors: excessive descent rate or airspeed on final, rounding out too high, and poor power management. Add a hard touchdown, and letting the nose-wheel fall instead of controlling its descent.

**GROUND MODULE 8 · AIRPORT SIGNS, MARKINGS, AND LIGHTS**

# READING THE AIRPORT: SIGNS AND SURFACE MARKINGS

**SOURCE** North Aero Ground Module 8 (Airport Signs) + AIM Ch 2, Section 3, Airport Marking Aids and Signs

Every sign on the airport uses a color code, and the colors carry the meaning. White letters on a red background are mandatory instruction signs. They mark an entrance to a runway or critical area, or an area where aircraft are prohibited. The most common is the runway holding position sign, such as 26-8. The numbers are arranged to match the thresholds: the threshold for runway 26 is to your left, and the threshold for runway 8 is to your right. The no entry sign is also red and white. Yellow letters on a black background are location signs, and they tell you which taxiway or runway you are on right now. Black letters on a yellow background, with arrows, are direction and destination signs, and they point toward intersecting taxiways and toward destinations such as runways, ramps, or fuel. Runway distance remaining signs are black with a white numeral, showing the landing runway remaining in thousands of feet. Your ground module boils it down to one line. Red always means stop or get a clearance first. Yellow means information.

Colors code the pavement the same way. Runway markings are white. Taxiway markings, closed areas, and holding positions are yellow, even when they are painted on a runway. Runway numbers come from the magnetic direction of the runway: the whole number nearest one tenth of the centerline's magnetic azimuth. Threshold stripes mark the beginning of the runway available for landing, and sometimes that threshold is displaced. A displaced threshold is marked with a 10 foot wide white bar across the runway, with white arrows leading up the centerline to it. The pavement behind it still works for takeoff in either direction, and for the rollout when landing the opposite way, but you may not touch down on it. A yellow demarcation bar separates a displaced threshold runway from a blast pad, stopway, or taxiway in front of it, and yellow chevrons mark pavement you may not use at all.

The most important marking on the airport is the runway holding position marking: four yellow lines across the taxiway, two solid and two dashed. Hold on the solid side. At a towered airport, stop before it and do not cross without an ATC clearance. Exiting after landing works in reverse, because you are not clear of the runway until all parts of the aircraft have crossed the marking. At a nontowered airport, the separating is your job, so make certain the runway and final are clear before you cross or enter. The taxiway centerline is a single continuous yellow line. Some airports add dashed lines on both sides of it for the last 150 feet before a hold line, a built-in warning to be ready to stop. Taxiway edge lines come in two types: a solid double yellow line means do not cross, and a dashed double yellow line means the pavement beyond it is meant for aircraft. The Comair 5191 thread from your ground modules lands here. The signs and markings at Lexington were all correct, and the crew did not use them. Read every sign, every time.

> *"They consist of four yellow lines, two solid and two dashed, spaced six or twelve inches apart, and extending across the width of the taxiway or runway. The solid lines are always on the side where the aircraft must hold."*

AIM 2-3-5, Holding Position Markings

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GROUND MODULE 8 · AIRPORT SIGNS, MARKINGS, AND LIGHTS

## AIRPORT LIGHTS: BEACONS, RUNWAY LIGHTING, AND THE GLIDE PATH

**SOURCE** North Aero Ground Module 8 (Airport Signs) + AIM Ch 2, Section 1, Airport Lighting Aids + PHAK 25C, Ch 14, Figures 14-29 and 14-30

At night, the rotating beacon tells you what kind of airport you found. White and green is a lighted civil land airport. A military airport also flashes white and green, but with dual peaked, two quick, white flashes between the greens. White and yellow is a lighted water airport. Green, yellow, and white is a heliport. The beacon carries a daytime message too. In Class B, C, D, or E surface areas, a beacon running during daylight often means the field is below basic VFR, with ground visibility under 3 miles and/or a ceiling under 1,000 feet. Treat that as a cue, not a report. Many beacons run on photocells or time clocks, so do not rely on the beacon alone. Check the weather.

The runway is outlined in white edge lights, in high, medium, or low intensity systems. On instrument runways, yellow replaces white in the last 2,000 feet or half the runway, whichever is less, as a caution zone. The lights at the runway ends are split: they show green outward to mark the threshold for landing traffic, and red toward the runway to mark the end for a departing airplane. Runway end identifier lights, or REIL, are a pair of synchronized flashing lights beside the threshold. They give rapid, positive identification of the approach end when the runway is buried in surrounding lights, lacks contrast with the terrain, or visibility is reduced. Taxiways are the blue ones. Blue edge lights outline them, and green centerline lights mark the middle at some airports.

At many airports, you run the lights. Pilot-controlled lighting works by keying the microphone on the published frequency, often the CTAF, listed in the Chart Supplement. Key the mike 7 times within 5 seconds for the highest intensity. Five clicks selects medium, and 3 selects low, and on some systems 5 or 3 clicks also turns the REIL down or off. The suggested technique never changes: key 7 times first, then adjust down. Each activation buys 15 minutes of light. Key the mike again as you approach, even if the lights are already on, so the clock restarts with you on final rather than in the flare.

Two light systems give you a visual glide path. Each VASI light unit projects white in the top of its beam and red in the bottom. On a two-bar VASI, on the normal 3 degree glidepath, the far bar shows red and the near bar shows white: red over white. Both bars white means high, and both red means low. The VASI provides obstruction clearance within 10 degrees of the extended runway centerline out to 4 NM, so do not start down it until you are visually aligned with the runway. The PAPI packs the same idea into a single row of two or four lights, normally on the left side. Read a four-light PAPI by the count. Two white and two red is on glidepath, about 3 degrees. Three white is slightly high, and four white is high, above 3.5 degrees. Three red is slightly low, and four red is low, below 2.5 degrees.

> *“In Class B, Class C, Class D and Class E surface areas, operation of the airport beacon during the hours of daylight often indicates that the ground visibility is less than 3 miles and/or the ceiling is less than 1,000 feet.”*

AIM 2-1-9, Airport/Heliport Beacons

GROUND MODULE 8 · AIRPORT SIGNS, MARKINGS, AND LIGHTS

# WIND INDICATORS, THE SEGMENTED CIRCLE, AND TAXIING IN WIND

**SOURCE** North Aero Ground Module 8 (Airport Signs) + PHAK 25C, Ch 14, Traffic Patterns + AFH 3C, Ch 2, Taxiing + AFH 3C, Ch 14, Taxiing

At an airport with no tower, the field itself reports the wind. The wind direction indicator can be a wind cone, wind sock, tetrahedron, or wind tee, usually near the runway and often at the center of a segmented circle. The sock is the best of them. It points downwind, away from where the wind is coming from, and you land into the wind. It also reports speed, because the sock stands out straighter as the wind strengthens and swings back and forth in gusts. Be careful with a tetrahedron or wind tee. They can swing with the wind, but they can also be manually set to the runway in use, so treat them as landing direction indicators and confirm with the sock.

The segmented circle marks the traffic pattern. It gathers the wind indicator, landing strip indicators, and traffic pattern indicators in one visible spot. The L-shaped pattern indicators, arranged in pairs, show which way to turn for each runway when the pattern is not standard left traffic. Your ground module's rule: the short leg of the L represents the base leg. Overfly, read the wind, pick the runway most nearly into the wind, and use the L for that runway to confirm left or right traffic. Then check the sock once more on final. This is the same verification habit the Watsonville and Lexington cases teach: assess what is actually happening at the airport instead of acting on a pre-formed plan.

Wind works on you during taxi too, and this crosswind lesson is the day to build the control habit. In calm wind, hold the ailerons and elevator neutral; they are not steering devices on the ground. The aileron rule is the same for every airplane North Aero flies. Quartering headwind: hold the upwind aileron UP, stick into the wind, so the wind cannot lift the upwind wing. Quartering tailwind: hold the upwind aileron DOWN, stick away from the wind, so the wind from behind cannot get under a raised aileron. One memory line covers both: climb into a quartering headwind, dive away from a quartering tailwind.

The elevator is where gear type matters, and you will fly both types here. In the Warrior, tricycle gear, hold the elevator neutral in a quartering headwind and DOWN in a quartering tailwind. In the Citabria or Decathlon, tailwheel, usually hold the stick FULL BACK in a quartering headwind. That presses the tailwheel down and keeps its steering effective. If the headwind is strong enough to threaten to lift a wing, ease the stick closer to neutral. In a real tailwind, go stick forward, same as the Warrior. That presses the tail down and keeps the wind from getting under an up elevator and lifting the tail into the propeller. One tailwheel exception: in a light tailwind, prop wash can put a net headwind over the tail, and back stick may steer better. Sample the wind and put the elevator where it does the most good. The tailwind case is the dangerous one in both types, so memorize the pair.

> *"When taxiing with a quartering tailwind, the elevator should be held in the DOWN position, and the upwind aileron, DOWN."*

AFH 3C, Ch 2, Taxiing

> *"At the same time, elevator should usually be held full back to add downward pressure to the tailwheel assembly and improve tailwheel steering response."*

AFH 3C, Ch 14, Taxiing

**LESSON 8 · CROSSWIND, SLIPS, SOFT FIELD, GO-AROUNDS**

# *REVIEW QUESTIONS*

*Answer in writing before your preflight briefing. Key at the back of this volume.*

1. What are the two crosswind landing methods, and which does the AFH recommend?
2. In flight, how do you know the crosswind exceeds the airplane's capability to land on that runway?
3. Explain the difference between a sideslip and a forward slip.
4. Why can the airspeed indicator mislead you in a slip, and how do you compensate?
5. What crosswind capability is demonstrated when an airplane is certificated, and where do you find the number?
6. Runway 17, wind 140 at 25 knots. Using the PHAK crosswind component chart, what are the components?
7. On a soft-field takeoff, why hold a nose-high attitude through the roll, and what must you do immediately after lift-off?
8. Describe the soft-field touchdown and rollout technique.
9. What do you do with the ailerons during the crosswind after-landing roll, and why?
10. Decode the airport sign colors: red, black, and yellow backgrounds.
11. Describe the runway holding position marking and the rules for crossing it.
12. What may you do on the pavement behind a displaced threshold?
13. Name the beacon color codes, and say what a beacon in daylight can tell you.
14. How do you activate pilot-controlled lighting, and how long does it stay on?
15. On final you see two white and two red lights in a single row beside the runway. What is it telling you?
16. How do you read the wind sock and the segmented circle from overhead?
17. Position the controls for taxiing with a strong quartering tailwind from the left.
18. In a quartering headwind, how does taxi elevator technique differ between the Warrior and the Citabria?

**LESSON 9** · **PAIRS WITH GROUND MODULE 7**

# *The Mumble (Scenario: Lost Communications)*

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*On this flight, the alternator quits over the practice area. The battery slowly dies. Then you arrive at a towered airport with no working radio. This chapter gives you everything you need to fly that scenario well. You will learn how the electrical system fails and what the regulations actually permit. You will also learn the lost communication procedures and the complete light gun signal table. Read it before the flight. Then the failure feels like a checklist item, not a crisis.*

**MEMORY AID** · **FAA**

## Light Gun Signals

*The tower's light signals, restated compactly. Learn them cold, because in the air a light is the only instruction you will get.*

Steady green: cleared to land in flight. Cleared for takeoff on the ground.

Flashing green: return for landing in flight, with a steady green to follow at the proper time. Cleared for taxi on the ground.

Steady red: give way to other aircraft and continue circling in flight. Stop on the ground.

Flashing red: airport unsafe, do not land in flight. Taxi clear of the runway in use on the ground.

Flashing white: return to your starting point on the airport. Ground only.

Alternating red and green: exercise extreme caution, in every case.

AIM, Para 4-3-13, TBL 4-3-1

**MEMORY AID** · **FAA**

## Three Conditions to Land

*What the regulation requires before you may land at a towered field after your radio fails under VFR.*

1. Weather conditions at or above basic VFR weather minimums.
2. Visual contact with the tower maintained.
3. A clearance to land received. In practice, that clearance arrives as a steady green light.

14 CFR 91.129(d) + 91.126(d)

## WHERE YOUR RADIOS GET THEIR POWER

**SOURCE** PHAK 25C, Ch 7, Electrical System

Most aircraft have either a 14 or 28 volt direct current electrical system. The basic system has several parts: an alternator or generator, a battery, a master/battery switch, an alternator/generator switch, a bus bar with fuses and circuit breakers, a voltage regulator, an ammeter or loadmeter, and the wiring that ties them together. The engine-driven alternator supplies current to the electrical system and keeps a sufficient charge in the battery. The battery stores electrical energy for starting the engine, and it provides a limited supply of power if the alternator fails.

Here is the point that matters most in this scenario. The master switch feeds every electrical circuit except the ignition system. Your engine runs on its own ignition, so it does not care that the alternator died. What dies is everything electrical: radios, lights, the turn indicator, fuel gauges, pitot heat, and the rest of the equipment fed by the bus.

Many aircraft have a split master switch with a battery half and an alternator half. The alternator half lets you cut a failed alternator out of the system. Once you do that, the battery is all you have, and every item you leave on shortens the time until the radios go quiet.

The ammeter is how you catch the failure early, and its zero point sits in the center of the gauge. When the pointer is on the plus side, it shows the charging rate of the battery. A minus indication means the battery is losing more current than it is getting back. Some aircraft use a warning light instead of an ammeter, and others use a loadmeter, which shows the percentage of load on the alternator. In any of these cases, the PHAK sends you to the AFM/POH for the right action, so know your airplane's electrical failure checklist before you need it.

> *“A full-scale minus deflection indicates a malfunction of the alternator/generator. A full-scale positive deflection indicates a malfunction of the regulator. In either case, consult the AFM/POH for appropriate action to be taken.”*

PHAK 25C, Ch 7, Electrical System

> *“With the alternator half of the switch in the OFF position, the entire electrical load is placed on the battery. All nonessential electrical equipment should be turned off to conserve battery power.”*

PHAK 25C, Ch 7, Electrical System

# THE NORMAL RULES FOR A TOWERED FIELD

**SOURCE** 14 CFR 91.129 + AIM, Ch 4 Sec 3, Para 4-3-2

Class D airspace sits around an airport with an operating control tower. The regulation calls that airport the primary airport. Anyone operating in the Class D area must follow 91.129, on top of the basic airport rules in 91.126 and 91.127.

The core requirement is two-way radio communication. For an arrival, you must establish communications with the tower before you enter the airspace, and you must keep talking to them the whole time you are inside it. The AIM adds the practical technique. Make your initial callup about 15 miles from the airport. And unless the tower authorizes or directs otherwise, fixed-wing pilots approaching to land must circle the airport to the left.

Runways and taxiways are clearance territory. Under 91.129(i), you need an appropriate clearance from ATC to operate on a runway or taxiway at a towered airport, or to take off or land there. Keep that word clearance in mind. Nothing in the lost communications procedure removes the requirement for a landing clearance. It just changes how the clearance is delivered: by light instead of by voice.

> *"Arrival or through flight. Each person must establish two-way radio communications with the ATC facility (including foreign ATC in the case of foreign airspace designated in the United States) providing air traffic services prior to entering that airspace and thereafter maintain those communications while within that airspace."*

14 CFR 91.129(c)(1)

> *"No person may, at any airport with an operating control tower, operate an aircraft on a runway or taxiway, or take off or land an aircraft, unless an appropriate clearance is received from ATC."*

14 CFR 91.129(i)

GROUND MODULE 7 · COMMUNICATIONS AND LIGHT GUN SIGNALS

# ATIS: THE RECORDED HALF OF THE CONVERSATION

**SOURCE** North Aero Ground Module 7 (Communications) + AIM Ch 4, Section 1, 4-1-13, Automatic Terminal Information Service

Before you call a tower, you listen. ATIS is the continuous broadcast of recorded noncontrol information in selected high activity terminal areas. Its job is to unload the frequency, because routine information gets recorded once instead of read to every airplane. The broadcast lives on its own VHF frequency or on the voice channel of a local NAVAID, and the Chart Supplement shows which airports have one. Pick it up when cockpit duties are least pressing, well before the airspace boundary. In this lesson's scenario, that habit pays twice. You want the airport information on board while your battery still works.

A full ATIS gives you the airport name, a phonetic letter code, the time of the latest weather in UTC, wind direction and velocity, visibility, obstructions to vision, sky condition, temperature, dew point, altimeter, a density altitude advisory when appropriate, and the instrument approach and runway in use. Expect gaps. If the ceiling is above 5,000 feet and visibility is better than 5 miles, those items may be dropped, so silence about the sky means at least 5,000 and 5. The recording is remade with each hourly or special weather observation, and whenever pertinent data such as the runway in use changes.

The letter is the handshake. Each new recording carries a fresh phonetic code letter. On initial contact, tell the controller which one you heard, such as Information Sierra received. That one word tells the controller exactly what you already know, so they can skip everything current in the broadcast. If you acknowledge an old letter, or none at all, the controller reads you the pertinent information. One trap: saying you have the numbers means only that you received the wind, runway, and altimeter. It does not indicate receipt of the ATIS broadcast and should never be used for that purpose.

> *“Pilots should notify controllers on initial contact that they have received the ATIS broadcast by repeating the alphabetical code word appended to the broadcast.”*

AIM 4-1-13

# WHAT THE RULE SAYS WHEN THE RADIO FAILS

**SOURCE** 14 CFR 91.129(d) + 14 CFR 91.126(d) + 14 CFR 91.127(c)

The regulation anticipates exactly the situation in this lesson. Section 91.129(d) covers communications failure in Class D. Suppose the radio fails in flight under VFR. The pilot in command may operate the aircraft and land if three conditions are met. First, weather conditions are at or above basic VFR weather minimums. Second, visual contact with the tower is maintained. Third, a clearance to land is received. If the failure happens under IFR, the pilot must comply with 91.185 instead.

The same three-condition test appears in 91.126(d) for towered airports in Class G airspace. And 91.127(c) applies the identical language to towered airports in Class E airspace. Those sections also contain the general communications rule for any airport with an operational control tower. You must establish communications before 4 nautical miles from the airport, up to and including 2,500 feet AGL.

Notice what the rule does and does not give you. It does not let you land simply because your radio died. You may continue and land only in VFR weather, only while you can see the tower, and only after the tower clears you to land. In practice, that clearance arrives as a steady green light. That is why the light gun table later in this chapter is memory-required knowledge.

> *"Communications failure. Each person who operates an aircraft in a Class D airspace area must maintain two-way radio communications with the ATC facility having jurisdiction over that area."*

14 CFR 91.129(d)

> *"However, if the aircraft radio fails in flight, the pilot in command may operate that aircraft and land if weather conditions are at or above basic VFR weather minimums, visual contact with the tower is maintained, and a clearance to land is received."*

14 CFR 91.126(d)

# LOST COMMUNICATION PROCEDURES

**SOURCE** PHAK 25C, Ch 14, Lost Communication Procedures

The PHAK breaks the problem into three cases based on what still works: receiver dead, transmitter dead, or both dead.

Suppose the receiver is inoperative and you need to land at a towered airport. Stay outside or above the Class D airspace until you have figured out the direction and flow of traffic. Then advise the tower of your aircraft type, position, altitude, and intention to land. Continue, enter the pattern, and report your position as appropriate. Watch for light signals from the tower.

Suppose the transmitter is the dead half. Follow the same procedures, and also monitor the appropriate ATC frequency, because the tower can still talk to you. During daylight hours, acknowledge their transmissions by rocking the wings. At night, acknowledge by blinking the landing light.

Now suppose both receiver and transmitter are gone, which is where a dead battery leaves you. Remain outside Class D airspace until the flow of traffic has been determined. Then enter the pattern and watch for light signals.

After you land, the problem is not over. Radio malfunctions should be repaired before further flight. If repair is not possible, you may contact ATC by telephone to request a VFR departure without two-way radio communications. Be aware that no radio (NORDO) arrivals are not accepted at busy airports.

> *"If a receiver becomes inoperative and a pilot needs to land at a towered airport, it is advisable to remain outside or above Class D airspace until the direction and flow of traffic is determined."*
>
> PHAK 25C, Ch 14, Lost Communication Procedures

# LIGHT GUN SIGNALS, COMPLETE AND VERBATIM

**SOURCE** AIM, Ch 4 Sec 3, Para 4-3-13, TBL 4-3-1, Airport Traffic Control Tower Light Gun Signals

Towers control no-radio traffic with a directive light gun. It emits an intense narrow beam of red, white, or green light. The table below reproduces TBL 4-3-1 exactly. Learn it cold, because in the air a light signal is the only instruction you will get.

Steady green. Aircraft on the ground: Cleared for takeoff. Aircraft in flight: Cleared to land. Vehicles, equipment and personnel: Cleared to cross, proceed or go.

Flashing green. Aircraft on the ground: Cleared for taxi. Aircraft in flight: Return for landing (to be followed by steady green at the proper time). Vehicles, equipment and personnel: Not applicable.

Steady red. Aircraft on the ground: STOP. Aircraft in flight: Give way to other aircraft and continue circling. Vehicles, equipment and personnel: STOP.

Flashing red. Aircraft on the ground: Taxi clear of the runway in use. Aircraft in flight: Airport unsafe, do not land. Vehicles, equipment and personnel: Clear the taxiway/runway.

Flashing white. Aircraft on the ground: Return to starting point on airport. Aircraft in flight: Not applicable. Vehicles, equipment and personnel: Return to starting point on airport.

Alternating red and green. In every case, on the ground, in flight, or for vehicles: Exercise extreme caution.

The AIM is honest about the limitations. The pilot may not be looking at the tower when the signal is aimed at the aircraft, and a light signal can only transmit approval or disapproval of your anticipated action. There is also a night technique for getting the tower's attention. Between sunset and sunrise, turn on a landing light and taxi to a spot where the tower can see it, clear of the active runway. Leave the light on until signals are received.

> *“During daylight hours, acknowledge tower transmissions or light signals by moving the ailerons or rudder. At night, acknowledge by blinking the landing or navigation lights.”*
>
> AIM, Para 4-3-13

## IS THIS AN EMERGENCY? THE AIM'S ANSWER

**SOURCE** AIM, Ch 6 Sec 4, Two-way Radio Communications Failure

The AIM opens its lost communications section with a dose of realism. It is virtually impossible to write procedures for every possible situation. So pilots facing a situation not covered in the regulation are expected to exercise good judgment. If the situation demands it, do not be reluctant to use the emergency authority in 14 CFR 91.3(b). That rule lets a pilot deviate from the flight rules to the extent required to meet an emergency.

Now take a failure that happens in VFR conditions, or where you meet VFR conditions after the failure. The rule the AIM points to is simple: continue the flight under VFR and land as soon as practicable. The AIM's note adds that practicable does not mean as soon as possible. You are not required to land at an unsuitable airport, and you keep the prerogative of exercising your best judgment.

Set the transponder to talk for you. Squawking code 7600 tells any radar facility that can see you exactly what your problem is. The AIM does caution that you may not be in an area of radar coverage.

Before accepting that the radios are truly gone, try to reestablish contact. Attempt the previously assigned frequency, try a Flight Service Station, and remember that 121.5 MHz is available. The AIM says there is no priority among these actions. If the capability exists, do all at the same time. In this lesson's scenario, the battery is dying. So this troubleshooting happens early, while you still have transmit power.

> *“Whether two-way communications failure constitutes an emergency depends on the circumstances, and in any event, it is a determination made by the pilot.”*

AIM, Para 6-4-1

> *“If an aircraft with a coded radar beacon transponder experiences a loss of two-way radio capability, the pilot should adjust the transponder to reply on Mode A/3, Code 7600.”*

AIM, Para 6-4-2

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## FLYING THE MUMBLE, START TO FINISH

**SOURCE** PHAK 25C, Ch 7, Electrical System + PHAK 25C, Ch 14, Lost Communication Procedures + AIM, Ch 6 Sec 4 + 14 CFR 91.129

Put the pieces in scenario order. First, catch the failure: the ammeter shows a discharge, or the low-voltage light comes on. Run the POH electrical failure procedure and shed every nonessential load so the battery lasts as long as possible.

Second, use the battery while you have it, and tell ATC what is happening while you can still transmit. Squawk 7600 and plan your arrival. Decide now how you will enter, because when the battery dies you lose the ability to coordinate anything.

Third, fly the PHAK procedure at the towered field. Remain outside or above the Class D airspace until you have determined the direction and flow of traffic. Then enter the pattern and watch the tower for light signals. Confirm the weather is at or above basic VFR minimums, and keep the tower in sight. Those are two of the three legal conditions for landing. The third condition is the steady green light: your clearance to land.

Fourth, acknowledge every signal, wings by day and lights by night, then land and clear the runway. Do not fly again until the radio problem is fixed, or until you have telephone authorization for a NORDO departure. In the debrief, be ready to explain each decision in terms of the regulation and the light gun table. That is exactly what your instructor is going to ask about.

GROUND MODULE 7 · COMMUNICATIONS AND LIGHT GUN SIGNALS

# AFTER THE EMERGENCY: NTSB NOTIFICATION AND REPORTS

**SOURCE** North Aero Ground Module 7 (Communications) + 49 CFR 830.2, 830.5, and 830.15

The Mumble ends with a safe landing. Some flights do not, and 49 CFR Part 830 defines what you owe the NTSB afterward. The dividing line is the accident definition, quoted below. Watch its three elements. The clock runs from the first person boarding with the intention of flight until everyone has disembarked. The triggers are death or serious injury to any person, or substantial damage to the aircraft. A serious injury includes hospitalization over 48 hours starting within 7 days, a broken bone other than a simple fracture of a finger, toe, or nose, severe bleeding or nerve, muscle, or tendon damage, any internal organ injury, or serious burns. Substantial damage means damage that adversely affects structural strength, performance, or flight characteristics and would normally require major repair or replacement. Then comes the list of what does not count, and it surprises people. Damage to landing gear, wheels, tires, flaps, engine accessories, brakes, or wingtips is not substantial damage. An incident is any other occurrence that affects or could affect the safety of operations.

An accident requires immediate notification of the nearest NTSB office, by the most expeditious means available. So do certain serious incidents, even with no damage at all. From the 830.5 list, know these: flight control system malfunction or failure, a required flight crewmember unable to perform normal duties because of injury or illness, in-flight fire, an aircraft collision in flight, failure of an internal turbine engine component that throws debris, and damage to property other than the aircraft estimated over $25,000. An overdue aircraft believed to be in an accident triggers the same immediate call. That last item is the machinery behind the VFR flight plan search you learned in Lesson 5.

Notification is the phone call. The report is the paperwork. After an accident, the operator files NTSB Form 6120.1/2 within 10 days, or within 7 days if an overdue aircraft is still missing. For a serious incident, a written report is filed only if the NTSB asks for one. Until the NTSB releases the wreckage, preserve it. Move it only to remove injured or trapped people, to protect the wreckage from further damage, or to protect the public from injury.

> *“Aircraft accident means an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft with the intention of flight and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage.”*

49 CFR 830.2

> *"Engine failure or damage limited to an engine if only one engine fails or is damaged, bent fairings or cowling, dented skin, small punctured holes in the skin or fabric, ground damage to rotor or propeller blades, and damage to landing gear, wheels, tires, flaps, engine accessories, brakes, or wingtips are not considered "substantial damage" for the purpose of this part."*

49 CFR 830.2, Substantial damage

> *"A report on an incident for which immediate notification is required by § 830.5(a) shall be filed only as requested by an authorized representative of the Board."*

49 CFR 830.15(a)

**LESSON 9 · THE MUMBLE (SCENARIO: LOST COMMUNICATIONS)**

# *REVIEW QUESTIONS*

*Answer in writing before your preflight briefing. Key at the back of this volume.*

1. Your ammeter shows a full-scale minus deflection in cruise. What does that indicate, and what should you do?
2. Does an alternator failure affect the engine?
3. Under 14 CFR 91.129, your radio fails in flight under VFR. What three conditions must be met to land at a Class D airport?
4. With both transmitter and receiver dead, how does the PHAK say to approach a towered airport?
5. What does a flashing green light mean to an aircraft in flight? On the ground?
6. What does a steady red light mean to an aircraft in flight, and what does flashing red mean?
7. What does alternating red and green mean?
8. How do you acknowledge a light signal during the day? At night?
9. What transponder code do you set for lost communications? Is a comm failure automatically an emergency?
10. After landing without a radio, can you just fly home?
11. What is ATIS, and what does the phonetic letter at the end mean?
12. Does telling the tower you have the numbers mean you copied the ATIS?
13. Define an aircraft accident under 49 CFR 830, and contrast it with an incident.
14. Which events require immediate NTSB notification even if nobody is hurt?
15. A wingtip is damaged striking a taxiway light. Is that an accident, and what paperwork follows a real accident?

**LESSON 10** · **PAIRS WITH GROUND MODULE 9**

# *When the Fan Stops (Scenario: Engine Failure on Departure)*

*This flight is built around one question: the engine quits right after takeoff, so now what? On the ground, you will brief the scenario, review a real accident, and practice the CHORRD departure briefing on the ramp. In the air, your instructor will pull the power at every position in the pattern. You will see how G loading changes stall speed. And you will see for yourself why the turn back to the runway is called the impossible turn. This chapter gives you the physics of load factor and stall speed. It covers the FAA's guidance on emergency landings and turnbacks. It also covers the stall/spin awareness material that keeps this training safe.*

**MEMORY AID** · **FAA**

## Nose Down, Land Ahead

*The default response when the engine fails on departure.*

- Lower the nose and establish the proper glide attitude. That is always the first action.
- Pushing forward unloads the wing, which drops the stall speed below its 1G value.
- Plan to land straight ahead, or with only a slight turn, under control and as slowly as possible.
- Do not attempt a turn back unless a successful turn back will result.

AFH 3C, Ch 18, Engine Failure After Takeoff (Single-Engine)

**MEMORY AID** · **NORTH AERO TEACHING AID**

## CHORRD

*The North Aero departure briefing. Run it out loud on the ramp before every takeoff, so your engine failure plan exists before the engine quits.*

- C: Conditions. Wind, density altitude, runway surface, and anything unusual today.
- H: Hazards. Terrain, obstacles, traffic, and anything that limits your options.
- O: Operational Changes. Anything different from normal, such as weight, a new procedure, or an intersection departure.
- R: Runway. Which runway, how much of it you need, and your abort point.
- R: Return. The altitude below which you will NOT turn back, and what you will do instead.
- D: Departure Route. Where you are going after liftoff and the first heading and altitude.

*Letters per the North Aero CHORRD briefing card, confirmed by your instructor.*

**MEMORY AID · NORTH AERO TEACHING AID**

### A-B-C-D-E-F

*The engine failure flow. When the engine quits, work these six steps in order.*

A: Airspeed. Pitch for best glide immediately.

B: Best Field. Pick the best landing area within reach and commit to it.

C: Checklist. Run the engine failure checklist and attempt a restart if altitude allows.

D: Declare Emergency. Squawk 7700 and tell someone: MAYDAY on the frequency in use or 121.5.

E: Evacuation Plan. Brief passengers, unlatch the door, know how you will get everyone out.

F: Fire Prevention. Fuel selector, mixture, master, and mags per the checklist before touchdown.

*Letters per the North Aero engine failure flow, confirmed by your instructor. The exact switch and lever steps come from the Warrior POH checklist, not this card.*

## WHAT A STALL ACTUALLY IS

**SOURCE** AC 61-67C, Stall/Spin Effects and Definitions + PHAK 25C, Ch 5, Aerodynamics of Flight

Everything in this lesson rests on one aerodynamic fact: the wing stalls at an angle of attack, not at an airspeed. The angle of attack, or AOA, is the angle between the wing and the oncoming air. The advisory circular defines the stall cleanly, and it adds a warning that matters when the engine fails at low altitude. If you do not recover in a timely and appropriate manner by reducing the AOA, a secondary stall and/or a spin may result. All spins are preceded by a stall on at least part of the wing.

The PHAK says the same thing from the other direction. The stalling speed you memorize from the airspeed indicator is not a fixed value. It moves with weight, load factor, and configuration. What never moves is the critical angle of attack, which for most designs falls between roughly 16 and 20 degrees.

Why does this AC exist? Because a stall/spin at low altitude is one of the deadliest events in general aviation. The AC traces its origins to a study of accident data. That study found stall/spin accidents caused about one-quarter of all fatal general aviation accidents. NTSB statistics show that most stall/spin accidents happen when a pilot is momentarily distracted from the primary task of flying the aircraft. An engine failure after takeoff is precisely that kind of distraction, and it arrives at the worst possible altitude.

> *"A stall is a loss of lift and increase in drag that occurs when an aircraft is flown at an angle of attack (AOA) greater than the angle for maximum lift."*
>
> AC 61-67C, Para 100, Stall/Spin Effects and Definitions

> *"The stalling speed of a particular aircraft is not a fixed value for all flight situations, but a given aircraft always stalls at the same AOA regardless of airspeed, weight, load factor, or density altitude."*
>
> PHAK 25C, Ch 5, Aerodynamics of Flight

## G LOADING AND STALL SPEED: THE MATH THAT SAVES YOU

**SOURCE** AC 61-67C, Load Factor + PHAK 25C, Ch 5, Aerodynamics of Flight (Figure 5-39)

Load factor is the ratio of the lift the wings produce to the actual weight of the airplane and its contents, expressed in G. The relationship you will feel in flight on this lesson is simple and unforgiving: stall speed rises with the square root of the load factor. The AC's example makes it concrete. An airplane with a normal unaccelerated stall speed of 45 knots can be stalled at 90 knots under a load factor of 4 G's.

Banking is how pilots most often load the wing without realizing it. The PHAK explains why: in a level turn, centrifugal force adds to the aircraft's weight. The wing must produce enough extra lift to balance both, and you get that lift by pulling, which raises the angle of attack. And the AOA must keep increasing as bank increases. So the stalling speed of an aircraft is higher in a level turn than in straight-and-level flight. PHAK Figure 5-39 charts exactly how load factor and stall speed climb together as bank angle steepens.

Now run the relationship the other direction, because this is the life-saving half. If increasing load factor raises stall speed, then reducing load factor lowers it. When the engine quits and the nose is high, pushing forward does two things at once. It reduces the angle of attack directly, and it unloads the wing, dropping the stall speed well below its 1G value. Your instructor will demonstrate this at altitude, so you can feel how an unloaded wing simply does not stall. That is why the immediate response to a power failure on departure is to lower the nose first, before anything else.

The AC also warns about the trap hiding in the turn back. In a steep turn or spiral, the chance of stalling the airplane by raising the load factor is much greater than in normal cruise flight. A tight, pulled-around turn at low speed is exactly how the impossible turn kills.

One footnote so the numbers never confuse you. This AC rounds the 60 degree bank figure to 40 percent. The PHAK rounds the same square root of two to 41 percent. Same physics, same lesson.

> *"The stall is the result of excessive AOA - not insufficient airspeed. For example, at a 60° banked turn in level coordinated flight, the load factor is 2 G's and the stall speed increases 40 percent over the straight and level stall speed. A STALL CAN OCCUR AT ANY AIRSPEED, IN ANY ATTITUDE, AT ANY POWER SETTING."*

AC 61-67C, Para 100

> *"The aircraft's stall speed increases in proportion to the square root of the load factor. For example, an airplane that has a normal unaccelerated stall speed of 45 knots can be stalled at 90 knots when subjected to a load factor of 4 G's."*

AC 61-67C, Para 100g, Load Factor

## EMERGENCY LANDINGS: THE MINDSET

**SOURCE** AFH 3C, Ch 18, Emergency Landings

The Airplane Flying Handbook's emergency chapter opens with a rule of precedence you should internalize. Its guidelines are generic. If anything in the chapter conflicts with the manufacturer's recommended procedures for your make and model, the manufacturer's procedures win. Your POH engine failure checklist and glide speed are the real numbers for this flight. This chapter builds the judgment that surrounds them.

The emergency landing section exists to remove the panic from the decision. Its objective is to instill one piece of knowledge: almost any terrain can be suitable for a survivable crash landing, if the pilot knows how to use the airplane structure to protect themselves and their passengers.

Hold on to that idea during the pattern work in this lesson. The airplane is replaceable. A landing straight ahead into rough terrain, flown under control and as slowly as the airplane will fly, is a survivable event. The accident record's typical consequences come from fighting that reality. One killer is making a 180 degree turn back to the runway when available altitude is insufficient. The other is stretching the glide to reach a better looking spot, without regard for minimum control speed.

> *"If any of the guidance in this chapter conflicts in any way with the manufacturer's recommended procedures for a particular make and model airplane, the manufacturer's recommended procedures take precedence."*

AFH 3C, Ch 18, Introduction

## ENGINE FAILURE AFTER TAKEOFF

**SOURCE** AFH 3C, Ch 18, Engine Failure After Takeoff (Single-Engine)

When an engine fails during the initial climb, the AFH is direct about the first action: lower the nose and establish the proper glide attitude. If the engine does not restart, the next step is the decision this whole lesson trains. Land ahead, or turn back toward the point of departure? In the AFH's words, there is not much time to decide and a lot to consider.

The handbook's baseline answer favors straight ahead. Landing into the wind, under control, at the lowest possible speed minimizes the risk of injury. Turning back requires a more complex analysis and consideration of risk. The AFH allows one exception: at some urban airports with numerous hazards in the departure path, a pilot might turn back. But only if certain the airplane can reach the field from its current position, and only if the pilot has trained and practiced the turn back maneuver.

In the air, you will fly the failure at each pattern position, using the standard pattern leg names. Departure and upwind run along the extended centerline. Crosswind is at right angles off the takeoff end. Downwind runs parallel and opposite the landing direction. Base is at right angles off the approach end. Final runs along the extended centerline to the runway. Each position changes your altitude, your geometry, and therefore your options. Upwind low: land ahead, no turn back. Crosswind: evaluate the wind and pick from what is in front of the wing. Abeam the numbers on downwind: you may have the altitude for a modified pattern to the runway, and it becomes a judgment exercise. Base or final: hold glide speed, adjust the aim point, and commit.

> *“Continuing straight ahead or making a slight turn gives the pilot time to establish a safe landing attitude, and the landing occurs under control and as slowly as possible (assuming a takeoff made into a headwind).”*
>
> AFH 3C, Ch 18, Engine Failure After Takeoff (Single-Engine)

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## THE IMPOSSIBLE TURN

**SOURCE** AFH 3C, Ch 18, Engine Failure After Takeoff (Single-Engine)

The FAA has run the numbers on the turn back, and they are sobering. In the handbook's traditional example, an airplane climbs to 300 feet AGL when the engine fails. After a typical 4-second reaction time, the pilot elects to turn back using a standard rate turn of 3 degrees per second. At a glide speed of 65 knots, the turn radius is 2,100 feet. So completing the 180 leaves the airplane 4,200 feet to one side of the runway. It needs another 45 degrees of turn to point at it. The total change in direction is 225 degrees, which takes 75 seconds plus the 4-second reaction time. Gliding down at approximately 1,000 fpm, the airplane descends 1,316 feet. It arrives 1,016 feet below the runway. This example is why a turn back, if attempted, requires a higher bank angle. A standard rate or shallow turn consumes too much time, requires too much distance, and generates an unacceptable solution.

But the higher bank angle is its own trap, and this is where the G loading section pays off. If the airplane strikes the ground during the turn, cartwheeling could occur. If the pilot does not lower the nose enough during the turn, an accelerated stall and fatal crash may occur. Even a successful turn often sets up a downwind approach. The increased groundspeed there can rush a pilot not trained for landing downwind. The added kinetic energy also raises the likelihood of serious injury if the field cannot be made.

If you ever intend to have the turn back in your toolkit, the AFH says to earn it. Know the expected altitude loss in the turn for your specific make and model, and know whether the airplane can physically glide back after the turn. Train for it by practicing turns in both directions at a safe altitude, after a simulated failure. Determine the better direction to turn back, usually into a crosswind. Predict the altitude remaining after the turn, and know the distance to the landing zone. That is exactly what you will do on this flight, at altitude. You will fly it with a 45 degree bank and then a 30 degree bank, so you can see the altimeter tell the story.

The bottom line belongs to the handbook. A turn back at low altitudes presents an unacceptable risk for student pilots, low-time pilots, untrained pilots, and pilots without adequate proficiency. The same is true for pilots flying airplanes with insufficient glide performance to return to the field.

> *“Turning back to an airport after a low-altitude engine failure, also known as “the impossible turn,” presents many challenges, and a pilot who attempts to turn back without due consideration and training will need considerable luck to prevent disaster.”*

AFH 3C, Ch 18, Engine Failure After Takeoff (Single-Engine)

> *“The pilot should not attempt a turn back unless a successful turn back will result.”*

AFH 3C, Ch 18, Engine Failure After Takeoff (Single-Engine)

## WHERE STALL/SPIN ACCIDENTS LIVE IN THE PATTERN

**SOURCE** AC 61-67C, Stall and Spin Awareness Training

The advisory circular maps the danger zones, and they line up with the positions you will fly on this lesson. Many stall/spin accidents have occurred in takeoff and climbout conditions, particularly during go-arounds. A common causal factor is the pilot's failure to maintain positive control, due to a nose-high trim setting or premature flap retraction. High pitch attitude, high power, low airspeed: that is your departure profile, and it is also the go-around profile.

Many stall/spin accidents have also occurred in approach-to-landing conditions, in power-off situations. One example is a crossed control turn from base leg to final approach, resulting in a skidding or slipping turn. Another is trying to recover from a high sink rate on final using pitch alone.

The base-to-final skid deserves special attention, because it is the same error that kills in the turn back. Stall/spin accidents have occurred during the turn from base to final because the pilot attempted to rudder the airplane around. The pilot skids the turn to avoid overshooting the runway, or to avoid using excessive bank angle in the pattern. The lesson for your engine-out pattern work: stay coordinated and keep the nose down. Accept an overshoot or a different field rather than tighten a low turn with rudder.

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## EMERGENCY DESCENTS

**SOURCE** AFH 3C, Ch 18, Emergency Descents

The last tool in this lesson's kit is the emergency descent, for the day the problem is not a quiet engine but something that makes altitude the enemy. The need for the maneuver may come from an uncontrollable fire or a sudden loss of cabin pressurization. It may come from any other situation demanding an immediate and rapid descent.

Fly it by your POH, because configuration, airspeed, and bank are make-and-model specific. That is why the AFH's precedence rule from the start of this chapter applies here too. The handbook supplies the definition and the urgency. Your airplane's manufacturer supplies the procedure.

> *“An emergency descent is a maneuver for descending as rapidly as possible to a lower altitude or to the ground for an emergency landing.”*
>
> AFH 3C, Ch 18, Emergency Descents

**LESSON 10 · WHEN THE FAN STOPS (SCENARIO: ENGINE FAILURE ON DEPARTURE)**

# *REVIEW QUESTIONS*

*Answer in writing before your preflight briefing. Key at the back of this volume.*

1. Define a stall. At what airspeed does your airplane stall?
2. In a 60 degree banked level coordinated turn, what is the load factor? What happens to stall speed?
3. How does stall speed change with load factor? What does that mean when you push forward after an engine failure?
4. What is the first action when the engine fails during initial climb?
5. Walk through the FAA's 300-foot turnback example. Where does the airplane end up?
6. Why does a turn back require a steeper bank than standard rate? What is the danger of that steeper bank?
7. For whom does the AFH say a low-altitude turn back is an unacceptable risk?
8. Even if the turn back succeeds, what hazards remain?
9. Where in the traffic pattern do stall/spin accidents typically happen? What pilot error drives the base-to-final version?
10. What is an emergency descent, and when would you need one?

**LESSON 11** · **PAIRS WITH GROUND MODULE 10**

# *The Real Pickle (Scenario: Diversion)*

*You fly out to the practice area, work your maneuvers, and turn for home. But home is gone: weather has closed the airport. Now you must divert to an unfamiliar field. You will choose between a grass strip aligned with the wind and a paved runway with a strong crosswind. This chapter arms you for that decision. You will learn how to get and read weather before and during the flight. You will learn what to do if the situation leaves you unsure of your position. And you will learn the CARE and TEAM tools that turn a bad afternoon into a disciplined decision.*

**MEMORY AID** · **FAA**

## CARE

*The processing tool: how you evaluate each hazard you have perceived.*

C: Consequences. What happens if you press on?

A: Alternatives. What other options do you have, such as another field?

R: Reality. The actual wind, your actual currency, and your actual fuel.

E: External factors. The pressures outside the airplane, like everyone waiting for you at home.

PHAK 25C, Ch 2, CARE Checklist

**MEMORY AID** · **FAA**

## TEAM

*The performing tool: four ways to handle each risk once you have sized it up.*

T: Transfer. Should this decision involve someone else, such as a call to your instructor?

E: Eliminate. Is there a way to remove the hazard altogether?

A: Accept. Do the benefits of accepting the risk outweigh the costs?

M: Mitigate. What can you do to reduce the risk?

PHAK 25C, Ch 2, TEAM Checklist

**MEMORY AID · FAA**

### The Three Briefings

*Which weather briefing to ask for, and when.*

Standard: the most complete information and weather picture. Get it prior to the departure of any flight.

Abbreviated: a shortened version. Request it when a departure has been delayed, or to update a previous briefing.

Outlook: planning material only. Request it when planned departure is 6 hours or more away, then follow up closer to departure.

PHAK 25C, Ch 13, Weather Briefings

## THE THREE WEATHER BRIEFINGS

**SOURCE** PHAK 25C, Ch 13, Weather Briefings + AWH 28B, Ch 3, 3.3.1 Weather Briefings

Before every flight, gather all information vital to the nature of the flight, including an appropriate weather briefing. To get the right briefing, you need to know which of the three types fits your situation: standard, abbreviated, or outlook. The briefer also needs some facts from you, starting with whether the flight is VFR or IFR. Give your aircraft identification and type, departure point, estimated time of departure, flight altitude, route, destination, and estimated time en route. That information goes into the flight plan system. It can be referenced later, including when an aircraft is overdue or reported missing.

A standard briefing delivers a set list of items, in order and as they apply to your route. It starts with adverse conditions that might make you cancel or change the plan. It includes a VFR flight not recommended statement when the briefer judges VFR doubtful. Then comes a synopsis of the big weather picture. Current conditions follow, though they are omitted if departure is more than 2 hours away. After that come the en route forecast, the destination forecast, and forecast winds and temperatures aloft. The briefing closes with NOTAMs, known ATC delays, and closing items such as the frequencies for opening your flight plan.

Take the VFR flight not recommended advisory seriously. The Aviation Weather Handbook stresses two things about it. It is advisory in nature, and the final decision on whether the flight can be conducted safely rests solely with the pilot. Still, it is a briefer with all the data in front of them telling you the picture looks doubtful. Weigh it against your experience, your ratings, and your airplane.

This lesson's scenario is exactly why the follow-up habit matters. An outlook briefing the night before is planning material, not a launch decision. A standard briefing near departure time, plus an update if you get delayed, is what keeps a closing airport from surprising you.

> *"A standard briefing provides the most complete information and a more complete weather picture. This type of briefing should be obtained prior to the departure of any flight and should be used during flight planning."*

PHAK 25C, Ch 13, Standard Briefing

> *"An abbreviated briefing is a shortened version of the standard briefing. It should be requested when a departure has been delayed or when weather information is needed to update the previous briefing."*

PHAK 25C, Ch 13, Abbreviated Briefing

> *"An outlook briefing should be requested when a planned departure is 6 hours or more away. It provides initial forecast information that is limited in scope due to the time frame of the planned flight."*

PHAK 25C, Ch 13, Outlook Briefing

## SELF-BRIEFING AND FLIGHT SERVICE TODAY

**SOURCE** AWH 28B, Ch 3, 3.3.1 Weather Briefings and 3.3.3 Self-Briefing

The current Aviation Weather Handbook reflects how pilots actually brief now. Historically, Flight Service was the primary source for preflight briefings. Today, growing numbers of pilots use online weather resources through government or commercial providers, and you do not have to call anyone to be legal.

If you do prefer to call, the handbook encourages a self-briefing first. And 1-800-WX-BRIEF remains the number for the contiguous United States. FSS specialists are qualified and certified as pilot weather briefers by the FAA. They are not authorized to make original forecasts. But they are certified to translate and interpret available weather into what you can expect at departure, en route, and at destination. Ask questions. The briefing is considered complete when the pilot has a clear picture of what weather to expect.

The FAA contract provider's website is 1800wxbrief.com. There you can review weather, receive online preflight briefings, file flight plans, and set up notifications and alerts. All briefings provided by Flight Service, online or voice, are time-stamped and archived for 45 days. The handbook also suggests a final weather check right before departure, using online weather apps when possible. In this scenario, that check is the last chance to catch the system that will close your home field.

> *"Pilots may receive a regulatory compliant briefing without contacting Flight Service."*

AWH 28B, Ch 3, 3.3.1

> *“Conducting a self-briefing before contacting Flight Service provides familiarity of weather conditions applicable to the route of flight and promotes a better understanding of weather information.”*
>
> AWH 28B, Ch 3, 3.3.1

## READING A METAR

**SOURCE** PHAK 25C, Ch 13, Aviation Routine Weather Report (METAR)

The METAR is your snapshot of what a station is reporting right now. On a diversion, it is how you compare candidate airports. METARs are issued on a regular schedule unless significant weather changes occur. A special report called a SPECI can be issued at any time between routine reports to capture rapidly changing conditions.

A METAR reads in a fixed sequence. Take the PHAK's example: METAR KGGG 161753Z AUTO 14021G26KT 3/4SM +TSRA BR BKN008 OVC012CB 18/17 A2970 RMK PRESFR. The station identifier is a four-letter ICAO code. In the contiguous states, a three-letter identifier is preceded by K. The date-time group 161753Z means the 16th day at 1753 Zulu. AUTO flags an automated source. COR would flag a corrected report.

Wind is five digits, and the first three are the true direction the wind is blowing from. The last two are speed in knots, with G and a number for gusts. So 14021G26KT is wind from 140 at 21, gusting 26. VRB means variable direction. If direction varies more than 60 degrees with speed above six knots, a V group shows the extremes. Visibility is in statute miles (3/4SM). Weather comes as qualifiers plus phenomena. The plus sign means heavy, so +TSRA BR is a heavy thunderstorm with rain and mist. Sky condition, temperature and dew point, and the altimeter setting follow. That wind group is the heart of this lesson's runway decision. Practice pulling direction and gusts out of the string quickly.

> *“A METAR is an observation of current surface weather reported in a standard international format.”*
>
> PHAK 25C, Ch 13, Aviation Routine Weather Report (METAR)

## READING A TAF

**SOURCE** PHAK 25C, Ch 13, Terminal Aerodrome Forecasts (TAF)

The METAR tells you what is, while the TAF tells you what is expected at an airport. It uses the same descriptors and abbreviations as the METAR, so learning one teaches you both.

A TAF can be a routine forecast or an amended forecast (TAF AMD). It carries the ICAO station identifier, a date and time of origin, and a valid period group such as 0812/0912. In that group, the first two digits are the day and the next two are the starting hour UTC. Then come the ending day and hour. Forecast wind uses the same five-digit style as the METAR (15011KT). Forecast visibility is in statute miles, coded P6SM when greater than six miles.

The scope matters for diversion planning. A TAF covers only the area within five statute miles of the airport. Usually, only larger airports have one. The grass strip you are weighing in this scenario probably has no TAF. It may have no weather reporting at all. That means you will be reading the nearest reporting station and your own eyes. That is not a reason to avoid the field. It is a reason to think, and to keep the paved crosswind option alive until you have seen the windsock.

> *“A TAF is a report established for the five statute mile radius around an airport.”*

PHAK 25C, Ch 13, Terminal Aerodrome Forecasts (TAF)

> *“Each TAF is valid for a 24 or 30-hour time period and is updated four times a day at 0000Z, 0600Z, 1200Z, and 1800Z.”*

PHAK 25C, Ch 13, Terminal Aerodrome Forecasts (TAF)

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## LOST PROCEDURES

**SOURCE** PHAK 25C, Ch 16, Lost Procedures

A diversion in deteriorating weather is how pilots end up unsure of their position, so the lost procedures belong in this lesson. The PHAK's guidance is common sense executed calmly. And the stakes are real: getting lost in flight is a potentially dangerous situation, especially when low on fuel.

First, climb, being mindful of traffic and weather conditions. Altitude buys you radio and navigation reception range and radar coverage. If you are near a town, you may even be able to read its name on a water tower.

Second, use what is installed. A VOR or ADF receiver can fix your position by plotting an azimuth from two or more navigational facilities. GPS, panel mounted or portable, can give you position and the nearest airport directly.

Third, talk. Communicate with any available facility, using the frequencies shown on the sectional chart. A controller may offer radar vectors. Facilities can also provide direction finding assistance. In that case, the controller has you hold down the transmit button. Your transmissions let them plot your position and issue vectors. None of this works if pride keeps you quiet. Asking for help early is the airmanship move, not the embarrassing one.

> *“If a pilot becomes lost, there are some good common sense procedures to follow. If a town or city cannot be seen, the first thing to do is climb, being mindful of traffic and weather conditions. An increase in altitude increases radio and navigation reception range and also increases radar coverage.”*

PHAK 25C, Ch 16, Lost Procedures

## THE DIVERT DECISION

**SOURCE** PHAK 25C, Ch 2, Aeronautical Decision-Making (3P Model and Risk Management)

The hardest part of a diversion is not the navigation: it is the willingness. The PHAK is blunt about where the danger lives. If you are worried about missing a meeting, be realistic about how that pressure will affect you. It shapes not just your initial go/no-go decision, but also your inflight decisions to continue the flight or divert.

Build the decision before the flight. The PHAK recommends developing a list of good alternatives during your planning. In marginal weather, identify a reasonable alternative airport for every 25 to 30 nautical mile segment of your route. It also recommends preflighting your passengers. Prepare them for the possibility of delay and diversion, and involve them in your evaluation process. That way, nobody in the airplane is pushing to press on.

The chapter's cross-country example shows the technique this lesson wants you to copy. With the destination doubtful, the pilot picked a specific point in the trip as the place for the final continue or divert decision. That point was an en route navaid between the destination and the alternates. The pilot also managed family expectations by promising a phone call on arrival, instead of a hard ETA. A predetermined decision point converts a creeping, pressure-soaked judgment into a simple question you answer once.

Personal minimums do the same work one level up. Develop them in a non-flying environment, when there is no pressure to make a specific trip. Once developed, a personal minimums checklist gives you a clear and concise reference point. Use it for your go/no-go and continue/discontinue decisions. In this scenario, your crosswind personal minimum may be the single number that chooses between the grass strip and the paved runway.

> *“Your mental willingness to follow through on safe decisions, especially those that require delay or diversion is critical.”*

PHAK 25C, Ch 2, Aeronautical Decision-Making

> *“A good rule of thumb for the processing phase: if you find yourself saying that it will “probably” be okay, it is definitely time for a solid reality check.”*

PHAK 25C, Ch 2, CARE Checklist: Review Hazards and Evaluate Risks

## CARE AND TEAM: WORKING THE PROBLEM IN THE AIR

**SOURCE** PHAK 25C, Ch 2, CARE Checklist + TEAM Checklist

The PHAK's 3P model runs a continuous loop: perceive the hazards, process their impact, perform by acting, then start again. The CARE checklist is the processing tool. For each hazard you perceived, work through Consequences, Alternatives, Reality, and External factors. Apply it to this scenario. The consequence of pressing on to a closed airport is arriving with fewer options and less fuel. The alternatives are the grass strip into the wind, the paved runway with the crosswind, or another field entirely. The reality is the actual wind, your actual currency, and your actual fuel. The external factor is everyone waiting for you at home.

The TEAM checklist is the performing tool, and it gives you four ways to handle each risk. Transfer: should this decision involve someone else, such as a call to your instructor? Eliminate: is there a way to remove the hazard altogether? Accept: do the benefits of accepting the risk outweigh the costs? Mitigate: what can you do to reduce it? Choosing the grass strip eliminates the crosswind hazard while accepting an unfamiliar surface. Choosing the pavement accepts the crosswind while eliminating the surface unknowns. Landing at a third airport with better wind and a phone might beat both.

The goal is to take action and then keep evaluating the outcome. Once you have selected a course of action, the process begins anew, because the new circumstances require their own analysis. The decision-making is a continuous loop of perceiving, processing, and performing. On the flight, expect your instructor to ask you to narrate that loop out loud, starting the moment the weather closure appears.

> *“For each hazard that you perceived in step one, process by using the CARE checklist of: Consequences, Alternatives, Reality, External factors.”*

PHAK 25C, Ch 2, CARE Checklist: Review Hazards and Evaluate Risks

> *“Perform risk management by using the TEAM checklist of: Transfer, Eliminate, Accept, Mitigate to deal with each factor.”*

PHAK 25C, Ch 2, TEAM Checklist: Choose and Implement Risk Controls

**LESSON 11 · THE REAL PICKLE (SCENARIO: DIVERSION)**

# *REVIEW QUESTIONS*

*Answer in writing before your preflight briefing. Key at the back of this volume.*

1. Name the three types of weather briefings and when each is appropriate.
2. The briefer says VFR flight not recommended. Are you grounded?
3. Do you have to call Flight Service to be legally briefed?
4. What is a METAR and what is a SPECI?
5. Decode the wind group 14021G26KT.
6. What area does a TAF cover? How long is it valid, and how often is it updated?
7. You are unsure of your position. What are the first things to do?
8. What does the CARE checklist stand for, and when do you use it?
9. What does the TEAM checklist stand for? How would it apply to the grass strip versus crosswind runway choice?
10. Why should personal minimums be set on the ground rather than in the air?

CHECK YOUR WORK

# ANSWER KEY

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## LESSON 1 · INTRODUCTION TO FLIGHT

1. The pilot in command. Under 14 CFR 91.7, no person may operate a civil aircraft unless it is airworthy. The PIC is responsible for deciding the aircraft is in condition for safe flight.
2. The aircraft conforms to its type design and is in condition for safe operation, per 14 CFR 3.5(a).
3. One pilot says, You have the flight controls. The other acknowledges, I have the flight controls. The first pilot confirms, You have the flight controls. Both then make a visual check that the other person really has the controls.
4. Anti-authority, impulsivity, invulnerability, macho, and resignation. The antidote for invulnerability is: It could happen to me.
5. Pilot in command, Aircraft, enVironment, and External pressures. It divides the risks of a flight into four categories during preflight planning. That way each risk can be examined and mitigated, or the flight canceled.
6. Illness, Medication, Stress, Alcohol (within 8 hours, or 24 hours), Fatigue, and Emotion. It screens the pilot's physical and mental readiness to fly.
7. Slow enough that the airplane's movement depends on the throttle. When the throttle is closed, the airplane can be stopped promptly, without relying on the brakes.
8. Oil pressure. In most conditions it should rise to at least the lower limit within about 30 seconds. If it does not, shut the engine down immediately.
9. When exercising solo flight privileges. It must be carried during solo flight. The plastic certificate does not expire.
10. Use short, evenly spaced eye movements of no more than 10 degrees. Watch each area for at least 1 second. If another aircraft shows no relative motion but is growing in size, it is on a collision course. Immediate evasive action is required.
11. A regulation in 14 CFR is federal law. Violating it exposes you to FAA certificate action, civil penalties, or both. An AC is guidance. It describes an acceptable way to comply with a regulation, and following it is not legally required by itself.
12. The AFM/POH is aircraft specific and legally part of that aircraft's airworthiness. Under 91.9 you must operate within its limitations. Placards carry the same regulatory weight as the AFM, and only documented aircraft records, such as an AFM revision or an STC, can supersede them.
13. An accident involves death or serious injury, or substantial damage to the aircraft. An incident is any other occurrence that affects or could affect the safety of operations. Accidents require immediate notification to the nearest NTSB office, and

confirmed substantial damage requires a written report on Form 6120.1 within ten days.

14. Preventive maintenance only. Under 14 CFR 43.3(g), a pilot may perform the preventive maintenance items listed in Part 43 Appendix A on an aircraft that pilot owns or operates, outside parts 121, 129, and 135. Everything beyond that list requires a certificated mechanic.
15. For airmen, category is a broad classification of aircraft, such as airplane, rotorcraft, glider, or lighter-than-air. Class is a division within a category with similar operating characteristics, such as single engine, multiengine, land, or water. You are training for airplane category, single engine land class.
16. Your pilot certificate, a photo ID, and your medical certificate, each in physical possession or readily accessible in the aircraft per 14 CFR 61.3. The FAA, the NTSB, the TSA, and any federal, state, or local law enforcement officer may ask to inspect them.

## LESSON 2 · BASIC MANEUVERS: SLOW FLIGHT, STALLS, STEEP TURNS INTRO

1. Exceeding the wing's critical angle of attack. Airflow separates from the upper wing surface, and lift decreases rapidly. A stall is the result of too much AOA, not insufficient airspeed. It can happen at any airspeed, any attitude, and any power setting.
2. About 16 to 20 degrees, depending on design. For a given configuration it does not change. The airplane always stalls at the same AOA, regardless of weight, bank angle, temperature, density altitude, or CG.
3. Reduce the angle of attack with nose-down pitch control until the stall warning is eliminated. Then roll the wings level, add power as needed, and return to the desired flightpath.
4. Adding power typically reduces the altitude lost during recovery, but it does not eliminate the stall. The reduction in AOA is imperative.
5. About 5 to 10 knots above the 1G stall speed, just above stall warning activation. Complete the maneuver no lower than 1,500 feet AGL in a single-engine airplane.
6. Torque, slipstream effect, and P-factor produce a strong left yaw at high power and high AOA. The closer the airplane is to the stall, the more right rudder it takes to stay coordinated.
7. The load factor is 2G. The airplane stalls at a speed 41 percent higher than its 1G stall speed.
8. Name of the facility being called, your full aircraft call sign, your position when on the airport surface, and the type of message or your request if it is short.
9. Identify yourself as a student pilot on initial contact. For example: Dayton tower, Fleetwing One Two Three Four, student pilot. Controllers will give you extra assistance and consideration.

10. Straight and level flight, turns, climbs, and descents. They are the principal maneuvers that control the airplane through the six motions of flight. Every maneuver you fly is a combination of them.
11. Slowing below best glide speed with back pressure increases drag and shortens the glide. The airplane lands short, and a stall with loss of control is possible. Hold best glide speed.
12. Only in unaccelerated 1G flight, in coordinated flight, at one weight (typically maximum gross), and at a particular CG.
13. Coefficient of lift (from wing shape and AOA), air density, velocity squared, and wing area. In flight you directly control two of them: angle of attack and airspeed.
14. Lift is proportional to the square of velocity, so lift becomes four times greater. To hold altitude you must lower the nose and reduce the AOA.
15. The white arc runs from VS0, the landing configuration stall speed, up to VFE, the maximum flap extended speed. The green arc runs from VS1, the stall speed in a specified clean configuration, up to VNO, the maximum structural cruising speed. The yellow arc is the caution range, smooth air only. The red line is VNE, the never exceed speed.
16. VA, the design maneuvering speed. It is not painted on the dial. It is found on placards and in the AFM/POH, and it changes with aircraft weight.
17. It decreases. At the same speed a lighter airplane flies at a lower AOA, so it can pull more G before reaching the critical AOA and stalling. That means the structure can be overloaded at a lower speed. The PHAK example: VA may be 100 knots heavily loaded but only 90 knots when light.

## LESSON 3 · FOUR FUNDAMENTALS AND COORDINATION

1. The throttle is the total energy controller. By setting thrust against drag, it regulates the net gain or loss of total mechanical energy. The elevator is the energy distribution controller. Through pitch attitude, it allocates total energy between altitude and airspeed.
2. Rule 2, a lower total energy state. Reduce the throttle so thrust is less than drag, and pitch down just enough to maintain the desired speed. On reaching the target, readjust pitch and power, and retrim.
3. It is a combination of total energy and distribution errors, so use both controls at once. Advance the throttle while easing aft on the yoke, to regain altitude without changing airspeed.
4. The throttle. Altitude and airspeed deviating in the same direction is a total energy error, meaning too much total energy, so reduce power. Deviations in opposite directions are distribution errors, and those belong to the elevator.
5. The downward-deflected aileron on the rising wing creates more lift, and therefore more drag. That drag yaws the airplane opposite the bank. Counteract it with coordinated rudder in the direction of the turn. The most rudder is needed at low airspeed, high AOA, and large aileron deflection.

6. Torque reaction from the engine and propeller, the corkscrewing slipstream striking the vertical tail, gyroscopic action (precession) of the propeller, and asymmetric propeller loading, or P-factor.
7. At high AOA, the descending blade (the right side, viewed from the rear) meets a higher resultant velocity and takes a bigger bite of air. It produces more thrust than the ascending blade. The center of thrust moves right of the propeller disc, yawing the nose left.
8. A coupled lateral and directional oscillation. Roll and yaw are about the same magnitude but out of phase, so the nose traces a figure eight on the horizon. In most modern airplanes it dies out in a few cycles on its own.
9. At least 90 percent outside, on the natural horizon and scanning for traffic. No more than 10 percent inside, taking quick mental snapshots of the flight instruments to validate attitude and performance.
10. Lead the level-off by about 10 percent of the vertical rate: 50 feet before the target altitude at 500 fpm. Lead the rollout by half the bank angle: 15 degrees before the target heading in a 30 degree bank.
11. Establish the desired power, pitch attitude, and configuration first. Then trim to relieve the remaining control pressures. Retrim any time power, attitude, or configuration changes.
12. Flaps increase both lift and induced drag for a given AOA, allowing a high cruise speed and a low landing speed. Extension may cause a nose-up or nose-down pitching moment, depending on the airplane. Anticipate the pitch change, and retrim.
13. Intake: the piston moves down and the fuel-air mixture is drawn in through the open intake valve. Compression: the valve closes and the piston compresses the mixture. Power: the spark plugs ignite the mixture and the pressure drives the piston down, turning the crankshaft. Exhaust: the exhaust valve opens and the piston pushes the burned gases out.
14. The 75 drop is within the typical limit of 125 RPM or less. The 200 drop exceeds it, and it also blows the 50 RPM maximum spread. It can mean a fouled plug, a faulty magneto, improper timing, or a defective lead. Return the switch to BOTH, taxi back, and have a mechanic inspect it. That is a no-go.
15. The magnetos generate their own spark and need no battery. If the ignition switch is left on, or its ground wire is broken, moving the propeller can fire a cylinder holding residual fuel. Turn the ignition OFF after shutdown, and treat every propeller as live.
16. Water can hide above the drain. At Ukiah in 2021, a buckled tank skin trapped water away from the sump port, and a filler neck leak had let rain in. Both pilots sumped correctly and found normal-looking fuel. Take larger samples, inspect the filler neck area for staining, and involve a mechanic if the system's history is suspect.
17. The next higher grade of aviation gasoline. Never a lower grade, which can overheat the engine and cause detonation. Never automotive gas without an STC.

18. Carburetor ice was choking the venturi. The heat is melting it, and the melt water passing through the engine causes the roughness. Hold full carburetor heat. The roughness can last from 30 seconds to several minutes, then power should return. Removing the heat early lets the ice re-form.
19. Climbing, the air thins while fuel flow stays constant, so the mixture becomes too rich. Leaning decreases fuel flow to match. Descending with the mixture still leaned makes it too lean, which can cause detonation, roughness, overheating, and power loss. Enrich on the way down and be full rich before the pattern.

## LESSON 4 · STALL RECOVERY, GROUND REFERENCE, INSTRUMENT INTRO, GO-AROUND INTRO

1. A stall is a loss of lift and increase in drag that occurs when the aircraft is flown at an angle of attack greater than the angle for maximum lift. It is caused by exceeding the critical angle of attack, not by insufficient airspeed. It can occur at any airspeed, in any attitude, at any power setting.
2. First reduce the angle of attack, so the wing regains lift. Then smoothly apply maximum allowable power to increase airspeed and minimize altitude loss. Reducing angle of attack always comes before power.
3. Downwind is where groundspeed is highest, so it requires the steepest bank of the maneuver. Entering there establishes the steepest bank first. If it is too steep, you can exit and reposition farther from the reference.
4. Steepest when headed downwind, where groundspeed is fastest. Shallowest when headed upwind, where groundspeed is slowest.
5. About one-half to three-fourths of a mile outside the boundaries, parallel to them. Flying closer forces steep banks, which increase load factor and stall speed. That risk is greatest turning from downwind to crosswind.
6. The altimeter freezes at the altitude where the blockage occurred, and the VSI reads a continuous zero. The fix is the alternate static source, with POH corrections in mind.
7. Rigidity in space and precession. Rigidity in space means the spinning gyro stays fixed in its spin plane while the airplane moves around it. Precession means an applied force takes effect 90 degrees later in the direction of rotation.
8. Power, attitude, configuration. Apply full or maximum allowable power smoothly and without hesitation, then hold the nose to a safe attitude. Expect a nose-up pitch tendency and left yaw, which demand forward elevator pressure and right rudder. Then retract the flaps in increments, and the gear after a positive rate of climb.
9. Touching down at the lowest possible controllable airspeed, under control, because destructive energy quadruples when groundspeed doubles. Keep the cabin intact by sacrificing dispensable structure, like the wings, gear, and fuselage bottom.
10. The incipient phase runs from the stall and the start of rotation until the spin is fully developed. In a fully developed spin, the rotation rate, airspeed, and vertical speed are stabilized from turn to turn, and the flightpath is close to vertical. A flat spin, with the nose near level, may be extremely difficult or impossible to recover from.

11. Power to idle. Ailerons neutral. Rudder full opposite the rotation. Elevator briskly forward to break the stall. When rotation stops, neutralize the rudder and pull out of the dive smoothly. Opposite rudder comes first because it attacks the lift difference that sustains the rotation. Pulling back first deepens the stall on already-stalled wings and can accelerate the spin.
12. The top of the green arc is VNO, the maximum structural cruising speed. Exceed it only in smooth air. Maneuvering speed, VA, is not marked. It is found on a placard and in the POH, and it decreases as the airplane gets lighter.
13. It shows a false turn toward north. ANDS covers speed changes: Accelerate North, Decelerate South, on east or west headings. OSUN covers turns: Overshoot South, Undershoot North, because the compass leads through south and lags through north.
14. Any five of: airspeed indicator, altimeter, magnetic direction indicator, tachometer for each engine, oil pressure gauge, oil temperature gauge for each air-cooled engine, and a fuel gauge for each tank. The rule also requires equipment such as safety belts and an anticollision light system on newer airplanes.
15. In a prolonged constant turn the inner ear stops sensing rotation, so you feel level while descending in a bank. Pulling back only tightens the spiral. Recover by reducing power, leveling the wings on the attitude indicator regardless of what your body says, and then smoothly raising the nose.

## LESSON 5 · EMERGENCY PROCEDURES AND INSTRUMENT FLYING

1. The PIC is directly responsible for the operation of the aircraft and is the final authority over it. In an emergency requiring immediate action, the PIC may deviate from any rule of 14 CFR part 91 Subparts A and B, as far as required to meet the emergency. If a clearance was violated, notify ATC as soon as possible.
2. Distress is a condition of being threatened by serious and/or imminent danger and of requiring immediate assistance. Urgency is a condition of being concerned about safety and of requiring timely but not immediate assistance. It is a potential distress condition.
3. The moment you become doubtful about position, fuel endurance, weather, or any other condition that could adversely affect flight safety. That is when to ask for help, not after it becomes distress.
4. MAYDAY for distress and PAN-PAN for urgency. Repeat each one three times, preferably, at the start of the transmission. MAYDAY commands radio silence on the frequency. Urgency traffic has priority over everything except distress.
5. Squawk 7700 with Mode C. That normally triggers an alarm at all radar control positions. Transmit on 121.5 MHz. Direction finding stations, most civil and military towers, and radar facilities guard that frequency.
6. No. Radar traffic information service is advisory and workload permitting. It is not intended to relieve the pilot of the responsibility for continual vigilance to see and avoid other aircraft.

7. Lower the nose and establish the glide attitude. Then land straight ahead or with a slight turn. Turning back requires roughly 225 degrees of turning. It costs more altitude than you have, and it tempts an accelerated stall near the ground. Do not attempt a turn back unless a successful turn back will result.
8. Satellites no longer monitor 121.5 MHz. The 406 MHz digital ELT is registered to the owner. Satellites detect it almost immediately. It narrows the search area, and it gets a SAR response in minutes instead of hours.
9. The pilot is responsible for closing it. Closure is not automatic. If you have not closed within one half hour after your ETA, a search will be started to locate you.
10. Trust the instruments and keep the wings level. Use the smallest practical bank angle, never more than 10 degrees. Make pitch changes of no more than one bar width. Keep any descent at or below 500 feet per minute. Do not combine climbing or descending with turns. Then get assistance from ATC.
11. Plan a no-flap landing. It can require up to 50 percent more runway. Fly a wider, longer pattern in a relatively nose-high attitude instead of diving to lose altitude. Expect considerable float in the round out. Do not force the airplane on at high speed, and do not flare excessively, because the tail can strike the runway.
12. One flap moves and the other stays put. The clue is a pronounced roll toward the wing with the least flap deflection as the flaps run. Counter the roll with opposite aileron and the yaw with substantial opposite rudder. Fly the approach faster than normal. Do not land with a crosswind from the side of the deployed flap. Fly the airplane onto the runway without an excessive flare, keeping a safe margin above the flaps-up stall speed.
13. A single failed cable usually costs only part of the pitch control. Apply considerable nose-up trim, then hold the desired attitude with forward pressure on the yoke. Increase forward pressure to lower the nose and relax it to raise the nose. Release the forward pressure to flare for landing. Trim tabs are weaker than the normal linkage at low airspeed, but usually enough to bring about a safe landing.

## LESSON 6 · MANEUVER REVIEW AND EMERGENCY PROCEDURES

1. Perceive, Process, Perform. You perceive hazards using the PAVE checklist: Pilot, Aircraft, enVironment, and External pressures.
2. Detect, Estimate, Choose a course of action, Identify solutions, Do the necessary actions, and Evaluate the effects of the actions.
3. The accurate perception and understanding of all the factors and conditions within the five fundamental risk elements that affect safety before, during, and after the flight. The five elements are flight, pilot, aircraft, environment, and type of operation.
4. Working harder while accomplishing less, with attention narrowing to one item. Stop, think, slow down, and prioritize. Keep aircraft control first.
5. Reduce the angle of attack. Hold the nose-down input until the stall warning is eliminated. Leveling the wings or adding power before reducing angle of attack is a listed common error.

6. Failure to recognize a condition that warrants a rejected landing, and indecision. Delay in initiating the go-around follows them.

## LESSON 7 · TAKEOFFS AND LANDINGS, STEEP TURNS, STALLS

1. On base, a target of approximately 1.4 VSO, the stall speed in the landing configuration. On final, the manufacturer's recommended approach speed, or 1.3 VSO if the manufacturer gives none. Get the actual numbers for our airplane from the POH.
2. One in which the pilot establishes and maintains a constant-angle glide path toward a predetermined point on the landing runway. It is based on judgment of visual cues, and on holding a constant final descent airspeed and configuration. For a piston single, that means roughly a constant 3 degree path, centerline tracking, airspeed within plus 10 or minus 5 knots, correct configuration, and a 500 to 1,000 fpm descent.
3. Apply power immediately while raising the pitch attitude to stop the descent. Then re-establish the stabilized approach. Wrong fix one: raising the nose without adding power, which decays airspeed toward a stall. Wrong fix two: retracting the flaps, which causes a sudden loss of lift and a faster sink.
4. At about 10 to 20 feet above the ground in a normal descent. Apply back-elevator pressure gradually, so pitch and angle of attack increase slowly while the airplane keeps settling. Time it so the landing attitude and touchdown speed arrive together just as the wheels touch. Once the round out starts, never push the elevator forward.
5. If the bounce is severe, go around immediately: full power, maintain directional control, and lower the nose to a safe climb attitude. Do not try to salvage the landing. Only a very slight bounce with no extreme pitch change may be followed by a landing. Cushion it with power and keep any crosswind correction in.
6. 1.41 at 45 degrees and 2.0 at 60 degrees. Stall speed increases with the square root of the load factor. An airplane that stalls at 50 knots wings level stalls at about 60 knots at 45 degrees of bank, and 70 knots at 60 degrees.
7. At or below VA or VO, the airplane reaches the critical angle of attack and stalls before the design load limit can be exceeded. The stall unloads the wing. Above those speeds, the airplane can reach its design load limit below the critical angle of attack. That makes it possible to overstress the structure.
8. When weather conditions permit, vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft. That applies whether the operation is IFR or VFR. Traffic patterns, tower services, and cockpit traffic displays never remove that responsibility.
9. A series of short, regularly spaced eye movements that bring successive areas of the sky into the central visual field. Each movement is no more than 10 degrees, and you observe each area for at least 1 second. The eye can only focus on and classify objects within roughly 10 to 15 degrees. The full see-recognize-react chain takes about 12.5 seconds, so a lazy scan leaves no time to avoid.

10. Preferred: announce and cross midfield at least 500 feet above pattern altitude (2,000 feet AGL where large or turbine aircraft operate). Fly well clear of the pattern by about 2 miles, scan, and descend to pattern altitude. Then turn to enter on the 45 to the downwind at midfield. Alternate: a midfield crosswind entry at pattern altitude, but not when the pattern is busy.
11. Whenever it produces lift, from rotation on takeoff to touchdown on landing. Strength grows with more weight and less speed, and a clean wing keeps the wake alive longer. The greatest vortex strength comes from a generating aircraft that is heavy, clean, and slow.
12. Its wake begins at the point where it rotated. Note that rotation point and land well before it. If you cannot land with margin before that point, go around or ask for more separation. Wake separation is your responsibility once you accept the sequence.
13. A crosswind of 1 to 5 knots can hold the upwind vortex in the touchdown zone, and a tailwind pushes the vortices forward into the touchdown zone. A light quartering tailwind does both. It can park an invisible vortex right where you plan to land, so it requires maximum caution.
14. The Saratoga entered a 737's descending vortex core 600 feet below the jet's flight path while above maneuvering speed. The stabilator and left wing separated in flight. At or below VA, a wake encounter is a violent but recoverable upset. Above VA, it can exceed the structure's limits. Stay at or above the preceding aircraft's path, and keep speed at or below VA when an encounter is possible.

## LESSON 8 · CROSSWIND, SLIPS, SOFT FIELD, GO-AROUNDS

1. The crab method and the wing-low (sideslip) method. The wing-low method is recommended in most cases. It keeps the ground track and longitudinal axis aligned with the runway through touchdown. Testing standards allow either, and pilots should learn both. A combination is also acceptable: crab down final, then transition to wing-low before the round out.
2. The bank required to stop the drift is the test. If full opposite rudder does not prevent the airplane from turning at that bank, the wind is too strong to safely land on that runway. Land on a more favorable runway at that airport, or at an alternate airport.
3. In a sideslip, the longitudinal axis stays parallel to the original flightpath. The nose keeps pointing down the runway, and the airplane moves sideways toward the low wing. It is used to stay aligned with the centerline in a crosswind. In a forward slip, the airplane's direction of motion over the ground continues unchanged, but the nose is yawed to the side with opposite rudder. It is used to dissipate altitude and steepen the descent without gaining airspeed.
4. Because of the location of the pitot tube and static vents, airspeed indicators in some airplanes read with considerable error in a slip. Recognize a properly performed slip by the airplane's attitude, the sound of the airflow, and the feel of the flight controls.
5. The airplane is flight tested to be satisfactorily controllable, with no exceptional pilot skill, in 90 degree crosswinds up to 0.2 VSO. That is two-tenths of the power-off stall speed in landing configuration. For an airplane that stalls at 45 knots, that is a 9

knot direct crosswind. The demonstrated crosswind velocity is placarded in airplanes certificated after May 3, 1962, and published in the AFM/POH.

6. The wind angle is 30 degrees (170 minus 140). Follow the 30 degree line to the 25 knot arc. That gives a headwind component of 22 knots and a crosswind component of 13 knots.
7. The nose-high attitude transfers the airplane's weight from the wheels to the wings as early as possible. That minimizes drag from the soft or rough surface. The airplane lifts off in ground effect below a safe climb speed. So immediately after lift-off, gently lower the nose and remain in ground effect until reaching at least VX. Climb out early, and the airplane will settle back even at full power.
8. Touch down at the lowest possible airspeed, in a nose-high attitude, with power carried through the level-off and touchdown. Hold the nose-wheel off with back-elevator. Control the weight transfer from wings to wheels with elevator and power. Once committed, gently lower the nose-wheel with a slight power addition. Avoid the brakes, and add power if needed to keep moving on a very soft surface.
9. Keep increasing aileron deflection into the wind as the airplane slows. Hold the control fully toward the wind as the airplane comes to a stop. The ailerons lose effectiveness as airflow decreases, while the crosswind gains lifting force on the upwind wing. An unchecked rising wing, plus weathervaning, can lead to loss of directional control or a roll-over.
10. White on red is mandatory: a runway entrance or a prohibited area, and you do not pass it without a clearance at a towered airport. Yellow on black is a location sign that names the taxiway or runway you are on. Black on yellow with arrows is a direction or destination sign pointing the way. The module's rule: red always means stop or get a clearance first, and yellow means information.
11. Four yellow lines across the taxiway, two solid and two dashed. The solid lines are always on the side where the aircraft must hold. At a towered airport, never cross toward the runway without ATC clearance. Exiting, you are not clear of the runway until all parts of the aircraft have crossed the marking. At a nontowered airport, ensure adequate separation yourself before crossing.
12. Take off in either direction, and roll out across it when landing from the opposite direction. You may not touch down on it when landing toward the displaced threshold. It is marked by a 10 foot wide white threshold bar with white arrows leading to it along the centerline.
13. White and green is a lighted civil land airport. A military airport adds two quick white flashes between the greens. White and yellow is a water airport, and green, yellow, and white is a heliport. In a Class B, C, D, or E surface area, a beacon operating in daylight often means ground visibility under 3 miles and/or a ceiling under 1,000 feet. Do not rely on the beacon alone. Check the weather.
14. Key the microphone on the published frequency 7 times within 5 seconds for the highest intensity. Five clicks gives medium and 3 gives low, and on some systems 5 or 3 clicks also lowers or turns off the REIL. Always start with 7 clicks, then adjust down. Lighting runs 15 minutes from the most recent activation, so key the mike again inbound even if the lights are on.

15. That is a four-light PAPI showing on glidepath, about 3 degrees. More white means high and more red means low. Four white is above 3.5 degrees, and four red is below 2.5 degrees. On a two-bar VASI, on path is red over white: far bar red, near bar white. All white is high, and all red is low.
16. The sock points downwind, away from where the wind comes from, so land into the wind. A stiff, straight sock means strong wind, and a swinging sock means gusts. The segmented circle's L-shaped traffic pattern indicators show the turn direction for each runway when the pattern is not standard left traffic, with the short leg of the L representing the base leg. Pick the runway most nearly into the wind, confirm the pattern side, and check the sock again on final.
17. Stick away from the wind and forward. The upwind aileron, the left one, goes down, and the elevator goes down. That is the same in the Warrior and, in a strong tailwind, in the tailwheel airplanes too. These positions keep the wind from getting under the tail and the wing and nosing the airplane over. In a light tailwind in a tailwheel airplane, prop wash may favor back stick, so sample the wind.
18. The Warrior holds the elevator neutral. The Citabria usually holds the stick full back, which presses the tailwheel down and keeps its steering effective. Ease toward neutral only if the headwind is strong enough to threaten to lift a wing. The aileron is the same in both: upwind aileron up, stick into the wind.

## LESSON 9 · THE MUMBLE (SCENARIO: LOST COMMUNICATIONS)

1. A full-scale minus deflection indicates a malfunction of the alternator/generator. Consult the AFM/POH for the appropriate action. If the airplane has an alternator switch, use it to cut the failed alternator out of the system. Then turn off all nonessential electrical equipment to conserve battery power.
2. No. The master switch feeds every electrical circuit except the ignition system, so the engine keeps running. Once the battery is depleted, the failure takes out electrically powered equipment such as radios, lights, and the turn indicator.
3. First, weather conditions at or above basic VFR weather minimums. Second, visual contact with the tower maintained. Third, a clearance to land received.
4. Remain outside of Class D airspace until the flow of traffic has been determined. Then enter the pattern and watch the tower for light signals.
5. In flight, it means return for landing. A steady green will follow at the proper time. On the ground, it means cleared for taxi.
6. Steady red in flight means give way to other aircraft and continue circling. Flashing red in flight means the airport is unsafe, do not land. Flashing red on the ground means taxi clear of the runway in use.
7. Exercise extreme caution. It applies to aircraft on the ground, aircraft in flight, and vehicles.
8. During daylight hours, acknowledge by moving the ailerons or rudder. In flight, that means rocking the wings. At night, acknowledge by blinking the landing or navigation lights.

9. Squawk 7600. A two-way communications failure is not automatically an emergency. Whether it is one depends on the circumstances, and the pilot makes that call. The pilot may use 91.3(b) emergency authority if the situation requires it.
10. No. Radio malfunctions should be repaired before further flight. If repair is not possible, contact ATC by telephone to request a VFR departure without two-way radio communications. Also note that NORDO arrivals are not accepted at busy airports.
11. The continuous broadcast of recorded noncontrol information at busy terminal areas. It carries the airport name, a phonetic code letter, the weather observation time, wind, visibility, sky condition, temperature, dew point, altimeter, and the approach and runway in use. Each new recording carries a fresh letter. Tell the controller the letter on initial contact, such as Information Sierra received, so they know your information is current.
12. No. Have numbers means you received the wind, runway, and altimeter information only. It does not indicate receipt of the ATIS broadcast and should never be used for that purpose. Acknowledge the ATIS by repeating its code word.
13. An occurrence associated with the operation of an aircraft, between the time any person boards with the intention of flight and all such persons have disembarked, in which any person suffers death or serious injury, or the aircraft receives substantial damage. An incident is any other occurrence that affects or could affect the safety of operations.
14. The listed serious incidents, including flight control system malfunction or failure, a required crewmember unable to perform normal duties from injury or illness, in-flight fire, an aircraft collision in flight, turbine engine failure that releases debris, and property damage other than the aircraft estimated over $25,000. An overdue aircraft believed to be in an accident also requires immediate notification.
15. Damage limited to a wingtip is expressly excluded from substantial damage under 830.2, so by itself it does not meet the accident definition and requires no NTSB notification. Have it inspected before further flight. After a real accident, notify the nearest NTSB office immediately and file NTSB Form 6120.1/2 within 10 days. An incident report is filed only when the NTSB requests one.

## LESSON 10 · WHEN THE FAN STOPS (SCENARIO: ENGINE FAILURE ON DEPARTURE)

1. A stall is a loss of lift and increase in drag. It occurs when an aircraft is flown at an angle of attack greater than the angle for maximum lift. There is no single stall airspeed. The airplane always stalls at the same critical AOA. The airspeed at which that AOA is reached varies with weight, load factor, and configuration. A stall can occur at any airspeed, in any attitude, at any power setting.
2. The load factor is 2 G's. The stall speed increases 40 percent over the straight and level stall speed.
3. Stall speed increases in proportion to the square root of the load factor. Pushing forward reduces the angle of attack and unloads the wing. That lowers the stall

speed below its 1G value. So lowering the nose immediately is what keeps the wing flying.

4. Lower the nose and establish the proper glide attitude. Then decide where to land. The default is straight ahead, or a slight turn to a field in front of the airplane.
5. The engine fails at 300 feet AGL. After a 4-second reaction time, the pilot turns back at standard rate, gliding at 65 knots. The turn radius is 2,100 feet. That leaves the airplane 4,200 feet to the side of the runway, needing 225 degrees of total heading change. The turn takes 75 seconds plus the reaction time. Descending at about 1,000 fpm, the airplane loses 1,316 feet. It arrives 1,016 feet below the runway. It does not make it.
6. A standard rate or shallow turn consumes too much time and distance. It generates an unacceptable solution. But steeper bank raises the load factor, which raises the stall speed. If the pilot does not lower the nose enough during the turn, an accelerated stall and fatal crash may occur.
7. Student pilots, low-time pilots, untrained pilots, and pilots without adequate proficiency. It also names pilots flying airplanes with insufficient glide performance to return to the field.
8. The return often results in a downwind approach. The increased groundspeed can rush the pilot. The increased kinetic energy raises the likelihood of serious injury if the field cannot be made. The turn may also require more than 180 degrees of heading change, and overshooting the runway is possible.
9. They happen during takeoff and climbout, particularly go-arounds with nose-high trim or premature flap retraction. They also happen during power-off approach situations. The base-to-final accidents come from skidding the turn with rudder to avoid overshooting the runway. The fix is accepting the overshoot or using coordinated flight.
10. It is a maneuver for descending as rapidly as possible to a lower altitude, or to the ground for an emergency landing. It may be required by an uncontrollable fire or a sudden loss of cabin pressurization. Any situation demanding an immediate and rapid descent qualifies. Fly it using the manufacturer's procedure.

## LESSON 11 · THE REAL PICKLE (SCENARIO: DIVERSION)

1. Standard: the most complete information. Get it prior to the departure of any flight, and use it during flight planning. Abbreviated: a shortened version. Request it when a departure has been delayed, or to update a previous briefing. Outlook: request it when planned departure is 6 hours or more away. It provides initial forecast information limited in scope. Follow it up with a standard or abbreviated briefing closer to departure.
2. No. The statement is advisory in nature, and the final decision rests solely with the pilot. Weigh it carefully against the current and forecast weather, your experience and ratings, and the aircraft's equipment and limitations.
3. No. Pilots may receive a regulatory compliant briefing through online weather resources, without contacting Flight Service. Pilots who prefer to call are

encouraged to conduct a self-briefing first. Flight Service briefings, online or voice, are time-stamped and archived for 45 days.

4. A METAR is an observation of current surface weather reported in a standard international format. It is issued on a regularly scheduled basis. A SPECI is a special METAR. It can be issued at any time between routine reports, for rapidly changing weather or other critical information.
5. Wind from 140 degrees true at 21 knots, gusting to 26 knots. The first three digits are the direction the wind is blowing from. The next two are speed in knots. G precedes the peak gust.
6. A TAF covers the five statute mile radius around an airport. Each TAF is valid for a 24 or 30 hour period. It is updated four times a day, at 0000Z, 0600Z, 1200Z, and 1800Z.
7. Climb, being mindful of traffic and weather. Altitude increases radio and navigation reception range and radar coverage. Use navigation equipment to fix your position, such as VOR azimuths from two or more facilities, or GPS. Communicate with any available facility, using frequencies from the sectional chart. Controllers can give radar vectors or direction finding assistance.
8. Consequences, Alternatives, Reality, External factors. Use it in the processing step of the 3P model. It helps you evaluate each hazard you have perceived and decide how much it matters to the safety of the flight.
9. Transfer, Eliminate, Accept, Mitigate. Choosing the into-wind grass strip eliminates the crosswind risk while accepting an unfamiliar surface. The paved runway accepts the crosswind risk while eliminating surface unknowns. Mitigation could include picking a third airport. Transfer could mean getting input from an instructor or briefer before deciding.
10. Because they should be developed in a non-flying environment, when there is no pressure to make a specific trip. A personal minimums checklist then gives a clear and concise reference point for go/no-go and continue/discontinue decisions. That way, the diversion decision is partly made before the pressure arrives.

**VERIFICATION NOTES**

# *SOURCES, GAPS, AND ESTIMATES*

Every chapter in this volume was drafted from FAA source text fetched on July 7, 2026 (PHAK FAA-H-8083-25C, AFH FAA-H-8083-3C, Aviation Weather Handbook FAA-H-8083-28B, AIM Basic with Change 2, 14 CFR from the eCFR, AC 61-67C, AC 90-48E), then independently verified: more than twenty verbatim quotes were re-fetched and compared character for character against their sources, including the complete light gun signal table, the AFH turnback warnings, and the stabilized approach definition. Non-breaking hyphens in AIM quotes were normalized to standard hyphens for print.

The honest edges of that verification:

- Lesson 1: POH general familiarization was assigned for this lesson: POH material not reproduced; read the airplane copy.
- Lesson 1: North Aero Ground Module 1B uses AC 00-6 as its advisory circular example; AC 00-6 was replaced by the Aviation Weather Handbook (FAA-H-8083-28B), so a different example is used in this chapter.
- Lesson 1: North Aero Ground Module 1B cites the FAA AD database at rgl.faa.gov; the FAA now hosts regulatory guidance in the Dynamic Regulatory System (drs.faa.gov). AD research details deferred to the maintenance lesson.
- Lesson 2: AFH 3C Ch 3 official PDF has no extractable text layer; Ch 3 content grounded in a faithful secondary transcription (fivemilefinal.com) and flagged for spot-check against the official PDF before print.
- Lesson 2: Aircraft-specific airspeeds and configurations for slow flight and stalls come from the POH: POH material not reproduced; read the airplane copy.
- Lesson 2: PHAK 25C Ch 5 PDF text extraction truncated before the Load Factors and Vg diagram sections; the weight dependence of VA is grounded in PHAK 25C Ch 8, Other Airspeed Limitations, instead.
- Lesson 2: North Aero Ground Module 2 states the critical AOA is approximately 15 to 18 degrees for most GA aircraft; PHAK 25C states approximately 16 to 20 degrees. The PHAK figure, already quoted in this lesson, governs.
- Lesson 3: AFH 3C Ch 3 official PDF has no extractable text layer; Ch 3 content grounded in a faithful secondary transcription (fivemilefinal.com) and flagged for spot-check against the official PDF before print.
- Lesson 3: Aircraft-specific power settings, airspeeds, and configurations come from the POH: POH material not reproduced; read the airplane copy.
- Lesson 3: Source conflict: North Aero Ground Module 3 states that descending with a leaned mixture makes the mixture progressively richer. PHAK 25C, Ch 7, Mixture Control states the opposite: during a descent the mixture must be enriched or it may become too lean. This chapter follows the PHAK. The module's operational bottom line (enrich on descent, full rich before the pattern) is unchanged.
- Lesson 3: Runup magneto-drop limits of 125 RPM and a 50 RPM spread are the typical values taught in North Aero Ground Module 3; per PHAK 25C, Ch 7, the permissible decrease for a specific airplane is listed in its AFM/POH, which governs.
- Lesson 4: Aircraft-specific V-speed values (VS0, VS1, VFE, VNO, VNE, VA and glide speed) are POH material and are not reproduced; read the airplane copy.

- Lesson 4: PHAK Ch 8 also covers electronic flight displays (EFD), AHRS, magnetic compass, and AOA indicators; those portions are beyond this lesson's assigned scope and are not summarized here.
- Lesson 4: AFH Ch 7 sections on turns around a point, elementary eights, and eights on pylons were fetched but are deferred to later lessons per the assigned reading (intro through S-Turns plus Rectangular Course).
- Lesson 4: The ANDS and OSUN memory aids and the compass-error discussion do not appear in the North Aero Ground Module 4A text as provided; compass errors here are grounded directly in PHAK 25C, Ch 8. ANDS appears in the PHAK by name (FAA tag). OSUN does not appear in PHAK 25C and is tagged as a North Aero packaging of the PHAK turning-error rules.
- Lesson 4: The PARE acronym does not appear in AC 61-67C or in the North Aero Ground Module 2 text; the recovery sequence itself matches both sources. PARE is tagged as a North Aero teaching mnemonic.
- Lesson 4: 14 CFR 91.205(b) is covered at awareness level only; the full paragraph lists 17 items, condensed here. Read the regulation for the complete list.
- Lesson 4: North Aero Ground Module 2 gives spin recovery and spin aerodynamics but does not name the spin phases; phase definitions are grounded in AC 61-67C, Par. 110.
- Lesson 5: POH emergency procedures are the controlling checklist for this airplane and are not reproduced here; read the airplane copy. All AFH Chapter 18 guidance is generic and the manufacturer's procedures take precedence.
- Lesson 5: AIM 6-2 material on the FAA K-9 explosives detection program, ground-air body signals, and ditching swell evaluation tables, and AIM 6-3 material on air piracy and fuel dumping, were fetched but condensed out as beyond private pilot Lesson 5 scope.
- Lesson 5: AFH Ch 18 sections on flight control malfunctions, landing gear malfunctions, ballistic parachutes, and emergency autoland were fetched; only the portions relevant to this airplane and lesson stage are summarized.
- Lesson 5: North Aero Ground Module 5 does not cover flight control malfunctions or brake and tire failure; the Flight Control and Landing Gear Malfunctions section is grounded directly in AFH Chapter 18.
- Lesson 5: Trim runaway and brake or tire failure on landing are not addressed in AFH Chapter 18 or in Ground Module 5, so they are not summarized here; the POH is the controlling source for those failures.
- Lesson 6: AFH 3C Ch 3 official PDF has no extractable text layer; its common errors lists are covered here from AFH Ch 5, 7, and 9 instead, and Lessons 2 and 3 carry Ch 3 content from a verified secondary transcription flagged for spot-check against the official PDF before print.
- Lesson 6: POH emergency procedures are the controlling checklist for the emergency procedures review and are not reproduced; read the airplane copy.
- Lesson 7: Aircraft-specific V-speeds, flap settings, and approach speeds are not reproduced here: get them from the airplane's POH.
- Lesson 7: The lesson task list also includes go-around practice and emergency descent review; the AFH go-around and emergency descent sections were not among this chapter's assigned readings, so they are not summarized here.
- Lesson 7: AC 90-48E as fetched quotes 14 CFR 91.113(g) verbatim and cites section 91.113 for see and avoid via the Pilot/Controller Glossary; the exact 91.113(b) text quoted in this chapter was fetched directly from the eCFR to guarantee verbatim accuracy.

- Lesson 7: North Aero Ground Module 6 states a light quartering tailwind of approximately 3 to 7 knots and a vortex sink rate of 300 to 500 fpm; the current AIM 7-4-4 states a 1 to 5 knot crosswind component can hold the upwind vortex in the touchdown zone and describes the sink as several hundred feet per minute. This chapter follows the AIM. Note the AIM now carries wake turbulence in Chapter 7, Section 4.
- Lesson 7: Ground Module 6 contains no instructional ADS-B traffic content beyond accident ground-speed data, so no ADS-B section was added; traffic displays and see-and-avoid limits are already covered in the collision avoidance section.
- Lesson 8: POH material not reproduced; read the airplane copy. Specifically, look up the maximum demonstrated crosswind component placard and figure in the POH before this lesson, along with the airplane's soft-field flap settings and speeds.
- Lesson 8: The lesson task list includes multiple go-around scenarios; the AFH go-around section was not among this chapter's assigned readings, so go-around procedure is not summarized here.
- Lesson 8: North Aero Ground Module 8 Layer 1 Q15 and Layer 2 Q3 give aileron UP on the upwind side for a strong quartering tailwind; AFH Chapter 2 directs the upwind aileron DOWN, with the elevator DOWN, for a quartering tailwind. This chapter follows the AFH. Flag Module 8 for correction.
- Lesson 8: Module 8 states a daytime beacon at a Class D airport indicates weather below VFR minimums; the current AIM 2-1-9 says it often indicates visibility below 3 miles and/or a ceiling below 1,000 feet, and warns pilots not to rely solely on the beacon. This chapter follows the AIM.
- Lesson 8: REIL, pilot-controlled lighting, and PAPI/VASI color combinations do not appear in the Module 8 text and were added from the AIM and PHAK. The VASI and PAPI on-path color combinations are presented in PHAK Figures 14-29 and 14-30 as graphics; the descriptions here follow those figures and the AIM's white-over-red beam principle.
- Lesson 9: PHAK Ch 14 PDF fetch truncated near the end of the chapter; the Radio Communications and Lost Communication Procedures sections used here were captured in full before the truncation point.
- Lesson 9: PHAK Ch 7 PDF fetch truncated mid-chapter; the Electrical System section used here was captured in full before the truncation point.
- Lesson 9: PHAK Figure 14-42 (light signal colors and meanings) is a graphic and did not extract as text; the light gun signal table was therefore reproduced verbatim from AIM TBL 4-3-1, as permitted by the assignment.
- Lesson 9: POH electrical failure checklist and aircraft-specific electrical system details are not reproduced; read the airplane copy.
- Lesson 9: North Aero Ground Module 7 Scenario 5 classifies a wingtip strike on a taxiway light as almost certainly substantial damage; 49 CFR 830.2 expressly excludes wingtip damage from substantial damage. This chapter follows the current regulation. Flag Module 7 for correction.
- Lesson 9: Ground Module 7 contains only brief ATIS usage examples in its radio-call scenarios; the ATIS section is grounded primarily in AIM 4-1-13.
- Lesson 10: PHAK Ch 5 PDF fetch truncated mid-chapter, before the Load Factors, Load Factors and Stalling Speeds, and Vg Diagram sections. The load factor and stall speed relationship in this chapter is grounded in the fetched AC 61-67C text and the fetched PHAK Ch 5 stall section (including Figure 5-39). The Vg diagram discussion is not covered here and should be added once the full section is retrieved.
- Lesson 10: POH engine failure procedures, best glide speed, and glide performance data are not reproduced; read the airplane copy and bring it to the ground briefing.

- Lesson 10: Verbatim quotes were extracted from PDF text; line breaks internal to the PDF extraction were joined with single spaces, with wording unchanged.
- Lesson 10: CHORRD and the A-B-C-D-E-F engine failure flow are North Aero teaching aids. Their letter expansions were supplied and confirmed by Erick Teeters on 2026-07-08; they are not FAA source material.
- Lesson 11: PHAK Ch 16 PDF fetch truncated inside the Lost Procedures section; the Flight Diversion section that follows it was not retrieved, so the PHAK diversion rule-of-thumb quote target could not be captured verbatim. The Divert Decision section here is grounded in fetched PHAK Ch 2 material instead. Fetch the Ch 16 Flight Diversion text and add its course-selection and rule-of-thumb guidance before publication.
- Lesson 11: Aviation Weather Handbook FAA-H-8083-28B is a very large PDF and the fetch truncated partway through Chapter 3; the assigned 3.3 Obtaining Weather Information material (weather briefings, telephone, and self-briefing) was captured and used, but later Chapter 3 sections and the rest of the handbook were not retrieved.
- Lesson 11: PHAK Ch 13 PDF fetch truncated later in the chapter; the Weather Briefings, METAR, and TAF sections used here were captured before the truncation point.
- Lesson 11: PHAK Ch 2 PDF fetch truncated later in the chapter; the CARE and TEAM checklist material used here was captured in full.
- Lesson 11: Aircraft crosswind limitations and performance for the runway decision come only from the POH; POH material not reproduced, read the airplane copy.

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North Aero, Inc. · Curriculum 5.1 · Workbook Volume 1 v2.0 (full ground-module parallel) · Sources verified 2026-07-07 · Readability standard per design-system/print-documents.md. This workbook supplements, and never replaces, the current FAA publications, the aircraft POH, and your instructor's assignments.