# NORTH AERO

AVIATION SERVICES · KSNS SALINAS, CALIFORNIA

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# PRIVATE PILOT WORKBOOK

## VOLUME 2 · CROSS-COUNTRY AND NIGHT · LESSONS 12-16

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

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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 12** · **PAIRS WITH GROUND MODULES 4A + 4B (REVIEW)**

# *Instrument Work, Compass, Unusual Attitudes, Short Field*

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*Phase 2 opens by sharpening the instrument skills you built in Phase 1. Today you fly climbs, descents, and turns to headings under the hood, including turns flown on the magnetic compass alone. You recover from unusual attitudes on instruments, and you meet the short-field takeoff and landing. You also put flight following to work for the whole flight. This chapter reviews and deepens. It does not start over.*

**MEMORY AID** · **FAA**

## ANDS

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

Accelerate: the compass shows a false turn toward North.

Decelerate: the compass shows a false turn toward South.

The error appears on easterly and westerly headings, where the tilted card catches magnetic dip during speed changes.

PHAK 25C, Ch 8, Acceleration Error

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

## OSUN

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

Undershoot North: the card leads on northerly headings, so stop the turn before the card reaches the target.

Overshoot South: the card lags on southerly headings, so let it pass the target before rolling out.

Amount either way: about 15 degrees plus half your latitude, per the PHAK rule of thumb.

*Named OSUN to match the Phase 1 ground checklist (ANDS, OSUN). The rule itself is verbatim PHAK; the packaging is North Aero.*

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

**MEMORY AID · FAA**

## 25 Up, 10 Down, 45 Bank

*The FAA upset parameters: exceed any one unintentionally and you are in an upset.*

Pitch attitude greater than 25 degrees nose up.
Pitch attitude greater than 10 degrees nose down.
Bank angle greater than 45 degrees.
Or airspeeds inappropriate for the conditions, even inside those limits.

AFH 3C, Ch 5, Defining an Airplane Upset

**GROUND MODULE 4A · INSTRUMENT SYSTEMS**

# HOOD WORK AT THE PHASE 2 STANDARD

**SOURCE** North Aero Ground Module 4A (Instrument Systems) + PHAK 25C, Ch 8, Heading Indicator

You built this scan in Lesson 4, when hood time was an introduction, and now it is a working skill. Today you fly straight-and-level, constant airspeed climbs, and constant airspeed descents by instruments alone. The attitude indicator is still your substitute horizon. Set the attitude, let the airplane settle, then confirm with the supporting instruments instead of chasing any single needle.

The heading indicator still needs your management. It is a free gyro, so bearing friction and the Earth's own rotation make it drift, and you check it against the magnetic compass about every 15 minutes. The PHAK is strict about when you may reset it, and the condition matters.

The strictness exists because the compass tells the truth only in steady flight, and tilting it or changing speed makes it lie in predictable ways. Those lies are the subject of the next two sections. The compass earns the attention: it is one of the basic instruments part 91 requires for both VFR and IFR flight, and it keeps working when the vacuum system quits.

> *“Adjust the heading indicator to the magnetic compass heading when the aircraft is straight and level at a constant speed to avoid compass errors.”*
>
> PHAK 25C, Ch 8, Heading Indicator

# HOW THE COMPASS WORKS AND WHY IT LIES

> **SOURCE** PHAK 25C, Ch 8, Compass Systems + Magnetic Compass Induced Errors

The magnetic compass is simple. Two small magnets ride on a float inside a bowl of clear compass fluid. A graduated card wraps around the float. You read your heading on the card opposite the lubber line, the vertical reference mark on the glass. The jewel-and-pivot mounting lets the float tilt only to about 18 degrees of bank. At steeper bank angles, the indications are erratic and unpredictable.

Two errors are built into every flight. Variation is the difference between true and magnetic directions. It depends on where you are, not which way you point. Deviation comes from the airplane's own magnetic fields, like electrical current and magnetized parts. It changes with heading. A technician minimizes it by swinging the compass, and the leftover error goes on the correction card by the instrument. You apply the two in order: true course corrected for variation gives magnetic course, and magnetic course corrected for deviation gives compass course.

The third troublemaker is magnetic dip. The Earth's field runs parallel to the surface only at the magnetic equator. Everywhere else it pulls downward or upward at an angle. The compass card only reads correctly while it stays horizontal. Once a turn or a speed change tilts the card, the vertical component of the field grabs it. Dip is what drives the turning and acceleration errors, and the errors grow as you fly closer to the poles.

# COMPASS TURNS: ANDS AND OSUN

> **SOURCE** PHAK 25C, Ch 8, Northerly and Southerly Turning Errors + Acceleration Error

Turning errors show up when you roll out on a compass heading. Rolling out on a heading near north, the card leads the airplane, so stop the turn early, before the card reaches the target. Rolling out on a heading near south, the card lags, so let it pass the target before rolling out. The PHAK rule of thumb for the amount is 15 degrees plus half your latitude, so near 40 degrees latitude you lead or trail the rollout by about 35 degrees. Remember OSUN: Overshoot South, Undershoot North.

Acceleration errors show up on east and west headings. The pendulous mounting tilts the card during speed changes, dip grabs the tilted card, and the compass shows a turn that is not happening. Remember ANDS: Accelerate North, Decelerate South.

Put it together for today's compass turns under the hood. Use smooth, shallow banked turns, apply OSUN at rollout, and ignore the compass during the turn itself, because it is tilted and lying. Then confirm the final heading the only way the compass allows: wings level, at a constant speed, with the card settled.

> *“Because of this lead of the compass card, or float assembly, a northerly turn should be stopped prior to arrival at the desired heading.”*
>
> PHAK 25C, Ch 8, Northerly Turning Errors

> *“The compass card, or float assembly, should be allowed to pass the desired heading prior to stopping the turn.”*
>
> PHAK 25C, Ch 8, Southerly Turning Errors

> *“When accelerating on either an easterly or westerly heading, the error appears as a turn indication toward north. When decelerating on either of these headings, the compass indicates a turn toward south.”*
>
> PHAK 25C, Ch 8, Acceleration Error

**GROUND MODULE 4B · UNUSUAL ATTITUDES AND EMERGENCY PROCEDURES**

# UPSETS AND HOW PILOTS GET THERE

> **SOURCE** North Aero Ground Module 4B (Unusual Attitudes) + AFH 3C, Ch 5, Defining an Airplane Upset

Lesson 4 introduced spatial disorientation and why your instruments outrank your inner ear. Phase 2 raises the bar to the FAA's upset framework. An upset is an event that unintentionally exceeds the parameters normally experienced in flight or training. The parameters are specific: pitch more than 25 degrees nose up, pitch more than 10 degrees nose down, bank more than 45 degrees, or airspeeds inappropriate for the conditions inside those limits.

A training unusual attitude is milder and expected. Your instructor sets it up, and you recover with no surprise. A real upset is unintentional, and it can startle you. The top contributing factors are environmental, mechanical, human, and stall-related. Turbulence, wake turbulence, and icing lead the environmental list. Continued VFR flight into marginal weather is the classic human factor. Losing the natural horizon invites spatial disorientation. So does diverting your attention to set avionics while the airplane drifts.

Prevention beats recovery. If what you see differs from what you expect, cross-check the instruments and confirm the attitude before making large inputs. Counter a developing upset early, with control inputs proportional to the rates of change you see. Small and early beats large and late.

> *“Safe pilots prevent loss of control in flight (LOC-I), which is the leading cause of fatal general aviation accidents in the U.S. and commercial aviation worldwide.”*

AFH 3C, Ch 5, Introduction

> *“Consistent with the Guide, the FAA considers an upset to be an event that unintentionally exceeds the parameters normally experienced in flight or training.”*

AFH 3C, Ch 5, Defining an Airplane Upset

**GROUND MODULE 4B · UNUSUAL ATTITUDES AND EMERGENCY PROCEDURES**

# RECOVERY: NOSE-HIGH AND NOSE-LOW

> **SOURCE** North Aero Ground Module 4B (Unusual Attitudes) + AFH 3C, Ch 5, Stall Recovery Procedure + Spiral Dive

Recovery starts with assessment. The AFH lists the common recovery errors, and the first one is misreading which kind of upset you are in. The others: failing to disconnect a wing leveler or autopilot, failing to unload the wing, rolling the wrong direction, and mismanaging airspeed. Read the attitude indicator, confirm it against the others, then act.

A nose-high attitude with decaying airspeed is the stall side of the problem. The sequence in a trainer: push to reduce the angle of attack until the stall warning stops, roll wings level, add power as needed, and return to the desired flightpath. Angle of attack comes first, every time. The AFH warns against fixing the bank before the wing is flying again.

A nose-low, banked, accelerating attitude is the spiral dive side. The AFH gives five steps. Reduce power to idle. Apply slight forward pressure to unload the wing to about positive 1G. Roll wings level with coordinated aileron and rudder. Gently raise the nose only after the wings are level and the speed is under control, because you may be near VNE. Then add climb power once stabilized. Pulling while still banked tightens the spiral, and a rolling pullout can exceed the airplane's design limits.

Under the hood today, your instructor will hand you the airplane in both conditions. Say the assessment out loud, then fly the matching sequence. Speed and smoothness both count, but order counts most.

> *“It is important not to be tempted to control the bank angle prior to reducing AOA.”*
>
> AFH 3C, Ch 5, Stall Recovery Procedure

# SHORT-FIELD TAKEOFF AND MAXIMUM PERFORMANCE CLIMB

> **SOURCE** AFH 3C, Ch 6, Short-Field Takeoff and Maximum Performance Climb + FAA-S-ACS-6C, Task PA.IV.E

A short field asks for the maximum limit of the airplane's takeoff performance. That starts before the runway. The POH gives the power setting, flap setting, airspeeds, and procedure, and those govern. On the runway, use the very beginning of the takeoff area. Set recommended flaps before you roll. Apply takeoff power smoothly and without hesitation. During the roll, hold a low-drag attitude for maximum acceleration.

As VX approaches, rotate smoothly and firmly. Then hold VX exactly. Climbing too steeply, or pulling the airplane off early, can settle you back onto the runway or into the obstacle. Keep the gear and flaps in takeoff position, and keep your eyes outside, until the obstacle is cleared and VY is established. Then clean up, flaps in increments.

The checkride tolerance is already your target: obstacle clearance speed or VX, plus 10 or minus 5 knots, to 50 feet. One fleet note. The AFH chapter describes nosewheel airplanes, where little elevator input is needed during the roll. Tailwheel technique differs, and it lives in AFH Chapter 14 and your airplane's POH. The performance logic is identical for both: full runway, exact VX, clean climb.

Common errors to self-check: not using all available runway, premature lift-off, holding the airplane down with excessive forward pressure, failing to hold VX, fixating on the airspeed indicator, and retracting gear or flaps too soon.

> *“After becoming airborne, the pilot will maintain a wings-level climb at VX until all obstacles have been cleared, or if no obstacles are present, until reaching an altitude of at least 50 feet above the takeoff surface.”*
>
> AFH 3C, Ch 6, Short-Field Takeoff and Maximum Performance Climb, Lift-Off

> *“Establish a pitch attitude to maintain the recommended obstacle clearance airspeed or VX, +10/-5 knots until the obstacle is cleared or until the airplane is 50 feet above the surface.”*
>
> FAA-S-ACS-6C, PA.IV.E.S10

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# SHORT-FIELD APPROACH AND LANDING

> **SOURCE** AFH 3C, Ch 9, Short-Field Approach and Landing + FAA-S-ACS-6C, Task PA.IV.F

The short-field landing is an accuracy approach to an aiming point, flown from a stabilized approach. A wider pattern with a longer final gives you time to configure and trim. The AFH procedure generally starts final at least 500 feet above the touchdown area, with full flaps extended at an appropriate point. With no published speed, fly no more than 1.3 VSO, and in gusty air add no more than one half the gust factor. Extra speed floats you past the aiming point and eats your stopping room.

Control the descent with pitch and power together. When obstacles are present, a slightly steeper approach places the touchdown closer to the obstacle and leaves more room to stop. If clearance looks excessive and touchdown will land long, reduce power and lower the pitch. If clearance looks doubtful, add power and raise the pitch. Any doubt about the outcome means go around, then decide.

Touch down with minimum float, then keep flying the airplane. Hold the positive pitch attitude for aerodynamic braking as long as the elevator stays effective, if the manufacturer recommends it, then brake as needed while holding the control wheel or stick full back. The ACS gives Phase 2 its measuring stick: a touchdown zone 200 feet deep. You will not hit it every time yet, but you will know exactly how far off you are.

> *“Touchdown should occur at the minimum controllable airspeed with the airplane in approximately the pitch attitude that results in a power-off stall when the throttle is closed.”*
>
> AFH 3C, Ch 9, Short-Field Approach and Landing

> *“Touch down at a proper pitch attitude within 200 feet beyond or on the specified point, threshold markings, or runway numbers, with no side drift, minimum float, and with the airplane's longitudinal axis aligned with and over the runway centerline.”*
>
> FAA-S-ACS-6C, PA.IV.F.S10

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## FLIGHT FOLLOWING AND THE DAY-VFR EQUIPMENT TIE-IN

> **SOURCE** AIM, 4-1-15, Radar Traffic Information Service + 14 CFR 91.205(b)

Today you request radar traffic advisories, called flight following, and keep them for the whole flight. The service is simple: a radar controller advises you of targets that may pass close to your route. Advisories arrive as a clock position, distance in miles, direction of travel, and type and altitude when known. The controller calls traffic from your radar track, not your nose. If you are holding a

crab, the traffic will sit a little off the called clock position, so widen your scan around it.

Know the limits. The service is workload permitting, and the controller has complete discretion to provide it or stop it. It does not include vectors away from traffic unless you ask. While receiving it, monitor the frequency at all times, tell the controller before you change frequencies, and report VFR altitude changes. When you drop the service, squawk 1200 again. Most important, the advisories never transfer your see-and-avoid responsibility.

One more Phase 1 review closes the preflight discussion. The day-VFR required equipment list in 14 CFR 91.205(b) is regulation, not opinion. Beyond the four instruments quoted below, the list includes an oil pressure gauge, an oil temperature gauge for each air-cooled engine, a fuel gauge for each tank, safety belts, and an anticollision light system on newer airplanes. Walk the panel against the rule before you fly.

> *“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, Radar Traffic Information Service

> *“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

**LESSON 12 · INSTRUMENT WORK, COMPASS, UNUSUAL ATTITUDES, SHORT FIELD**

# *REVIEW QUESTIONS*

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

1. When is the only acceptable time to reset the heading indicator to the magnetic compass, and why?
2. What is the difference between variation and deviation, and in what order do you apply them?
3. You are rolling out of a turn onto a heading of 360. What does OSUN tell you to do, and roughly how much?
4. Flying west, you accelerate on a go-around. What does the compass show, and what memory aid covers it?
5. Recite the FAA upset parameters.
6. You take the hood off in a nose-low, steeply banked, accelerating attitude. Walk through the recovery in order and explain why you must not pull first.
7. In a nose-high unusual attitude near a stall, what comes first in the recovery?
8. Describe the short-field takeoff from brake release to a safe altitude, including the ACS speed tolerance.
9. What approach speed does the short-field landing use when the POH gives none, and where must you touch down to ACS standard?
10. While receiving flight following, who is responsible for seeing and avoiding other aircraft, and what should you do before leaving the frequency?

**LESSON 13** · **PAIRS WITH GROUND MODULES 2-1 + 2-2**

# *First Dual Cross-Country*

*This is the flight where the airplane finally leaves the neighborhood. You will plan the whole trip, fly it with your instructor, and land at an airport you have never seen. This chapter walks you through the planning workflow: chart the course, build the nav log, compute fuel, pick an altitude, run weight and balance, brief the weather, and file the plan. Do the work on paper before the flight. A good cross-country is won at the kitchen table, not in the air.*

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

## The Cross-Country Planning Flow

*North Aero's planning sequence from Ground Module 2-1, run in this order for every cross-country. Each step feeds the next.*

1. NOTAMs and TFRs for departure, destination, and the route.
2. Weather briefing from an official source, self-brief plus standard briefing, never a surface observation alone.
3. Cruising altitude: airspace, terrain, obstructions, then the 91.159 direction rule.
4. True airspeed, forecast winds, groundspeed, and estimated time en route.
5. Fuel: time en route times burn rate, plus the legal reserve, checked against usable fuel.
6. File the VFR flight plan.
7. Chart Supplement study for every airport of intended use.

North Aero Ground Module 2-1 (Cross Country Planning), Scenario 1

**MEMORY AID** · **FAA**

## VFR Fuel Reserves

*The legal minimum fuel to begin a VFR flight in an airplane, computed at normal cruising speed after reaching the first point of intended landing.*

Day: fuel to the first point of intended landing plus 30 minutes.

Night: fuel to the first point of intended landing plus 45 minutes.

Both computations must consider wind and forecast weather conditions.

The reserve is a floor. Plan to land with it untouched.

14 CFR 91.151(a)

**MEMORY AID** · **FAA**

### From Chart to Compass

*The heading chain that converts the line on your chart into the number you hold on the compass.*

TC plus or minus WCA equals TH.

TH plus or minus variation equals MH.

MH plus or minus deviation equals CH.

Wind correction comes from the wind triangle. Variation comes from the isogonic line on the chart. Deviation comes from the compass card in your airplane.

PHAK 25C, Ch 16, Steps in Charting the Course

## PREFLIGHT ACTION IS A LEGAL STANDARD

**SOURCE** 14 CFR 91.103 + PHAK 25C, Ch 16, Flight Planning

Planning a cross-country is not merely good practice, because regulation 91.103 makes thorough preparation a legal obligation, and it opens with the sweeping command quoted below. The words all available information establish the standard. For any flight away from the airport neighborhood, that includes weather reports and forecasts, fuel requirements, alternatives if the flight cannot be completed, and known traffic delays.

Notice the second half of the rule. For any flight, you must know the runway lengths at every airport you intend to use. You must also know your takeoff and landing distance data. Your airplane has an approved handbook with those numbers, so those numbers are the ones you use.

Here is the mindset behind the regulation. Before engine start you hold complete information and complete authority, and you can still change the route, wait a day, or cancel entirely. Once airborne, your options begin to shrink. Every section that follows in this chapter is one piece of the 91.103 standard, done properly.

> *“Each pilot in command shall, before beginning a flight, become familiar with all available information concerning that flight.”*
>
> 14 CFR 91.103

> *“For a flight under IFR or a flight not in the vicinity of an airport, weather reports and forecasts, fuel requirements, alternatives available if the planned flight cannot be completed, and any known traffic delays of which the pilot in command has been advised by ATC;”*
>
> 14 CFR 91.103(a)

> *“For any flight, runway lengths at airports of intended use, and the following takeoff and landing distance information:”*
>
> 14 CFR 91.103(b)

GROUND MODULE 2-1 · CROSS COUNTRY PLANNING

# CHART THE COURSE

> **SOURCE** PHAK 25C, Ch 16, Charting the Course and Steps in Charting the Course + North Aero Ground Module 2-1 (Cross Country Planning)

Start with a current sectional chart and draw the course line from the center of your departure airport to the center of your destination. If the route is direct, that is a single straight line. If you route around terrain or over a helpful VOR, it becomes two or more straight segments.

Now pick checkpoints along the line. The PHAK wants easy-to-locate points: large towns, large lakes and rivers, or combinations like a town with an airport and a railroad. Choose towns shown as splashes of yellow on the chart. A town printed as a small circle may turn out to be a half-dozen houses.

Next, sweep the course and the areas on both sides for airspace, looking for any Class B, C, or D areas you will touch, and note their floors and ceilings. Then study terrain and obstructions, finding the highest elevation and the tallest obstruction along the route, because your cruising altitude has to respect both. Television towers can rise more than 1,500 feet above the surrounding terrain.

Finish with the Chart Supplement for every airport where you intend to land. Study the location, elevation, runways, lighting, fuel types, and frequencies. Check NOTAMs for anything that has changed since the Chart Supplement was published. When the chart and the Chart Supplement disagree, the Chart Supplement usually has the newer information, so use it.

# PILOTAGE AND DEAD RECKONING, WORKING TOGETHER

**SOURCE** PHAK 25C, Ch 16, Pilotage and Dead Reckoning

The two verbatim definitions below are examination material, so learn them as written. In practice the two methods run together: dead reckoning generates a predicted heading and groundspeed, while pilotage checks that prediction against the ground, checkpoint by checkpoint.

Choose checkpoints that other features help identify: roads, rivers, railroad tracks, lakes, and power lines. Better yet, find features that form brackets on each side of your course, like a highway on one side and a river on the other. Stay inside the brackets and you cannot drift far.

Two habits keep pilotage honest. First, never lean on one checkpoint. If you miss one, hold your heading and look for the next. Second, resist the urge to turn when a checkpoint does not appear on schedule. The PHAK is blunt about this: if confused, hold the heading. Turning away from a known heading is how pilots get lost. Remember the chart scale too. On a sectional, one inch equals about 8 statute miles, so a checkpoint half an inch from the course line sits about 4 miles from your track.

> *“Pilotage is navigation by reference to landmarks or checkpoints.”*
>
> PHAK 25C, Ch 16, Pilotage

> *“Dead reckoning is navigation solely by means of computations based on time, airspeed, distance, and direction.”*
>
> PHAK 25C, Ch 16, Dead Reckoning

> *“Never place complete reliance on any single checkpoint. Choose ample checkpoints. If one is missed, look for the next one while maintaining the heading.”*
>
> PHAK 25C, Ch 16, Pilotage

**GROUND MODULE 2-1 · CROSS COUNTRY PLANNING**

# THE NAV LOG: FROM TRUE COURSE TO COMPASS HEADING

> **SOURCE** PHAK 25C, Ch 16, Dead Reckoning, Wind Triangle, and Basic Calculations + North Aero Ground Module 2-1 (Cross Country Planning)

The nav log turns your chart work into numbers you can fly. The wind triangle is the engine behind it. If there were no wind, your track would match your heading and your groundspeed would match your true airspeed. That condition rarely exists. So you apply the forecast wind to your true course and true airspeed, and out come two products: the heading that keeps you on the line, and the groundspeed that sets your times.

The heading chain is one formula: TC plus or minus WCA equals TH, plus or minus variation equals MH, plus or minus deviation equals CH. Measure the true course with your plotter against a meridian, then compute the wind correction angle with your E6B or electronic computer. Apply magnetic variation from the isogonic line nearest your route, and apply deviation from the compass card in your airplane. The result is the compass heading you will actually hold.

The speed math is just as simple. Time equals distance divided by groundspeed, so 210 miles at 140 knots takes 1.5 hours. Distance equals groundspeed multiplied by time, and groundspeed equals distance divided by time, which is how you check yourself between checkpoints in flight. Enter a time and distance for each checkpoint leg on the log, and as the trip progresses, note actual times and adjust your heading, groundspeed, and estimates.

Remember that climb changes the numbers. Groundspeed during climb is less than in cruise at the same airspeed, so the first leg takes longer than cruise math suggests. The PHAK example trip adds five minutes for the climb. Build that pad into your log.

**GROUND MODULE 2-1 · CROSS COUNTRY PLANNING**

# FUEL: THE PLAN AND THE LAW

> **SOURCE** 14 CFR 91.151 + PHAK 25C, Ch 16, Fuel Consumption + North Aero Ground Module 2-1 (Cross Country Planning)

Fuel planning is fundamentally a groundspeed problem, because the engine burns by the hour, and a headwind that stretches the trip stretches the burn. Multiply your estimated time en route by the consumption rate from your airplane's handbook. The PHAK example makes the shape clear: 400 miles at 100 knots groundspeed is 4 hours, and at 5 gallons per hour that is 20 gallons. Plan for startup, taxi, and the higher burn in climb, not just cruise.

Then add the legal reserve, quoted below. Thirty minutes at normal cruising speed for day VFR. Forty-five minutes at night. Read the wording carefully. The rule counts fuel to the first point of intended landing, and it makes you consider wind and forecast weather. The reserve is a minimum, not a target. North Aero treats the reserve as fuel you plan never to touch.

The PHAK adds a hard backstop for the flight itself. You should always plan to be on the surface before your flight time exceeds the time you calculated for your fuel, and before the fuel gauge shows a low fuel level. If either line is approaching, the decision is already made, and you land and buy fuel.

> *“No person may begin a flight in an airplane under VFR conditions unless (considering wind and forecast weather conditions) there is enough fuel to fly to the first point of intended landing and, assuming normal cruising speed— (1) During the day, to fly after that for at least 30 minutes; or (2) At night, to fly after that for at least 45 minutes.”*
>
> 14 CFR 91.151(a)

GROUND MODULE 2-1 · CROSS COUNTRY PLANNING

# CHOOSING YOUR CRUISING ALTITUDE

> **SOURCE** 14 CFR 91.159 + PHAK 25C, Ch 16, Steps in Charting the Course + North Aero Ground Module 2-1 (Cross Country Planning)

Altitude selection has a legal layer and a judgment layer. The legal layer is 91.159, quoted below. It applies in level cruising flight more than 3,000 feet above the surface. Eastbound, meaning a magnetic course from zero through 179 degrees, you fly odd thousands plus 500. Westbound, 180 through 359, you fly even thousands plus 500. The scheme applies when you cruise more than 3,000 feet AGL and below 18,000 feet MSL, which covers every cross-country in this program.

Watch the word the regulation actually uses: magnetic course, not heading, because wind correction can put your heading in a different band than your course. The course is the track you are making over the ground, and that determines your altitude.

The judgment layer comes from your chart study. The PHAK example trip picks 5,500 feet because it clears the Class C and D airspace along the route, clears every obstruction, and fits the odd-plus-500 rule for an eastbound course. Run the same three checks for your own route: airspace, terrain and obstructions, then the direction rule. Cloud heights, winds aloft, and radio reception can all push the final choice up or down.

> *“Except while holding in a holding pattern of 2 minutes or less, or while turning, each person operating an aircraft under VFR in level cruising flight more than 3,000 feet above the surface shall maintain the appropriate altitude or flight level prescribed below, unless otherwise authorized by ATC:”*
>
> 14 CFR 91.159

> *“On a magnetic course of zero degrees through 179 degrees, any odd thousand foot MSL altitude + 500 feet (such as 3,500, 5,500, or 7,500); or”*
>
> 14 CFR 91.159(a)(1)

> *“On a magnetic course of 180 degrees through 359 degrees, any even thousand foot MSL altitude + 500 feet (such as 4,500, 6,500, or 8,500).”*
>
> 14 CFR 91.159(a)(2)

GROUND MODULE 2-2 · PERFORMANCE AND LIMITATIONS

# WEIGHT, BALANCE, AND PERFORMANCE FOR TODAY'S LOAD

> **SOURCE** PHAK 25C, Ch 16, Airplane Flight Manual or Pilot's Operating Handbook + North Aero Ground Module 2-2 (Performance and Limitations)

This is where Module 2-2 meets the real flight. Check the AFM/POH to determine the proper loading of the aircraft. You need the weight of the usable fuel and oil, the passengers, the baggage, and the empty weight from the airplane's current records, and you confirm the total stays under the maximum allowable weight. Then check the distribution, because the center of gravity must fall within limits too.

Weight and CG are separate limitations, and both must pass, because an airplane can be under gross weight and still be loaded outside the envelope. Module 2-2 explains why the aft limit matters so much: an aft-loaded airplane is less stable, stalls more readily, and gives the elevator less authority to recover. Legal weight with an illegal CG is a no-go.

Now performance. Determine takeoff and landing distances from the handbook charts using your calculated load, the airport elevation, and the temperature. Compare those distances with the runway available at every airport of intended use, which closes the loop on 91.103(b). The heavier the load and the higher the elevation, temperature, or humidity, the longer the rolls and the weaker the climb. Density altitude is pressure altitude corrected for nonstandard temperature, and it is the number the airplane actually feels. A cool coastal departure can end at a hot inland airport where the same airplane performs like it is thousands of feet higher. Run the numbers for the return leg before you leave. The specific figures come from your airplane's own handbook, not from this chapter.

**GROUND MODULE 2-1 · CROSS COUNTRY PLANNING**

# BRIEF YOURSELF, THEN FILE THE PLAN

> **SOURCE** AWH FAA-H-8083-28B, Ch 3, Weather Briefings and Self-Briefing + AIM, Para 7-1-5 + AIM, Para 5-1-5 and 5-1-14

Current FAA guidance expects you to be an active briefer, not a passive listener. You can receive a regulatory compliant briefing using online resources without ever calling Flight Service. If you do prefer to call, the FAA still encourages a self-brief first, because it builds familiarity with the conditions along your route. Either way, briefings come in three types, and you should know which one you need.

The three types are quoted below. A standard briefing is the complete picture: adverse conditions, a synopsis, current conditions, en route and destination forecasts, winds aloft, and NOTAMs. An abbreviated briefing updates or supplements information you already have. An outlook briefing serves planning when departure is six or more hours away, and it always deserves a follow-up standard or abbreviated briefing before you go.

One phrase deserves special respect. When conditions make VFR doubtful in the briefer's judgment, you will hear VFR flight not recommended. It is advisory, and the decision stays with you. Treat it as a strong invitation to slow down and rethink, especially at your experience level. Flight Service briefings, online or by voice, are time-stamped and archived for 45 days.

Now the flight plan itself. A VFR flight plan is not required inside the continental United States, but the AIM strongly recommends one, and North Aero expects one on every cross-country. The reason is search and rescue. An activated flight plan means someone starts looking for you if you do not arrive. Filing uses FAA Form 7233-4, the International Flight Plan, through 1800wxbrief.com, a flight planning app, or Flight Service by phone.

Filing is not activating. Your proposal just sits there until you activate it after takeoff, and proposals are only kept for about two hours past the proposed departure time. The AIM is explicit that pilots are responsible for activating flight plans with Flight Service, because control tower personnel do not automatically activate them. Closing is the step pilots forget, and the last quote shows what the mistake costs. Nobody closes the plan for you at a towered field. Call Flight Service, use the website or app, or ask any ATC facility to relay the cancellation. Build the habit now: wheels stop, flight plan closed.

> *“You should request a Standard Briefing any time you are planning a flight and you have not received a previous briefing or have not received preliminary information through online resources.”*

AIM, Para 7-1-5, Standard Briefing

> *“Request an Abbreviated Briefing when you need information to supplement mass disseminated data, update a previous briefing, or when you need only one or two specific items.”*

AIM, Para 7-1-5, Abbreviated Briefing

> *“You should request an Outlook Briefing whenever your proposed time of departure is six or more hours from the time of the briefing.”*

AIM, Para 7-1-5, Outlook Briefing

> *“This recommendation is advisory in nature. The final decision as to whether the flight can be conducted safely rests solely with the pilot.”*

AIM, Para 7-1-5, VFR Flight Not Recommended

> *“Control towers do not automatically close VFR or DVFR flight plans since they do not know if a particular VFR aircraft is on a flight plan. If you fail to report or cancel your flight plan within 1/2 hour after your ETA, search and rescue procedures are started.”*

AIM, Para 5-1-14

**LESSON 13 · FIRST DUAL CROSS-COUNTRY**

# *REVIEW QUESTIONS*

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

1. Before this cross-country, what does 14 CFR 91.103 specifically require you to know?
2. How do you pick good checkpoints when charting the course?
3. Besides drawing the line, what three chart checks does the PHAK build into charting the course?
4. Define pilotage and dead reckoning, and explain how they work together.
5. You expected a checkpoint two minutes ago and have not seen it. What do you do?
6. Walk through the formula that turns true course into compass heading.
7. How long does it take to fly 210 NM at a groundspeed of 140 knots, and what formula did you use?
8. State the VFR fuel minimums for this airplane, day and night.
9. Your magnetic course is 085 degrees and you will cruise more than 3,000 feet above the surface. What altitudes are legal?
10. The airplane is under max gross weight but the CG plots just aft of the limit. Can you go?
11. Name the three briefing types and when each is appropriate.
12. Who activates your VFR flight plan, who closes it, and what happens if you forget?

**LESSON 14** · **PAIRS WITH GROUND MODULES 2-1 + 2-3 + 2-4**

# *Dual Triangular Cross-Country*

*Lesson 13 taught you to fly one line. This lesson closes a triangle: three legs, multiple stops, and a landing at more than one unfamiliar airport. Along the way your instructor will take away your certainty. You will fly a simulated lost procedure, divert for simulated weather, cross airspace boundaries, and manage fuel across legs. This chapter gives you the procedures for each of those events before you need them in the air.*

**MEMORY AID** · **FAA**

## The Advisory Ladder

*The four inflight weather advisories, ordered by what they demand of a VFR pilot. If any of them touches your route, reopen the go or no-go decision.*

Convective SIGMET: thunderstorm hazards. Always implies severe or greater turbulence, severe icing, and low-level wind shear.

SIGMET: severe non-convective hazards. Severe icing, severe or extreme turbulence, widespread dust or sand below 3 miles visibility, volcanic ash.

AIRMET: the same families of weather at lower intensities. Aimed especially at VFR pilots and light aircraft.

CWA: a nowcast supplement for conditions starting within about two hours. Not a planning product.

AIM, Para 7-1-6

**MEMORY AID** · **FAA**

## AIRMET Sierra, Tango, Zulu

*The three AIRMET designators and the hazards each one carries. Match the letter to the hazard before you brief.*

Sierra: IFR conditions, ceilings below 1,000 feet or visibility below 3 miles, and mountain obscuration.

Tango: turbulence, sustained surface winds greater than 30 knots, and non-convective low-level wind shear.

Zulu: moderate icing and freezing level heights.

AWH FAA-H-8083-28B, Ch 3 + AIM, Para 7-1-6

**MEMORY AID** · **FAA**

### Lost: First Three Moves

*The PHAK's lost procedure, compressed to the actions you take before anything else. Hold your heading while you work.*

1. Climb, mindful of traffic and weather. Altitude extends radio, navigation, and radar reach.
2. Fix your position: plot azimuths from two or more navaids, or read position and nearest airport from GPS.
3. Communicate with any facility on the sectional. Accept vectors or direction finding help. Squawk 7700 if the situation becomes distress.

PHAK 25C, Ch 16, Lost Procedures + AIM, Para 6-2-2

**GROUND MODULE 2-1 · CROSS COUNTRY PLANNING**

## THREE LEGS, ONE DISCIPLINED PLAN

**SOURCE** PHAK 25C, Ch 16, Charting the Course + AIM, Para 5-1-5 + AIM, Para 6-2-6

A triangular cross-country is three Lesson 13 plans stapled together. Each leg gets its own course line, its own checkpoints, its own heading and groundspeed work, and its own airspace and obstruction study. The wind does not care that you are flying a triangle. Each leg has a different course, so each leg gets its own wind correction angle and its own groundspeed. A tailwind on the first leg often becomes a crosswind or headwind on the next.

The flight plan paperwork changes too. The AIM recommendation quoted below is simple: for a flight with stopovers, file a separate flight plan for each leg. The search and rescue logic behind it is spelled out in the AIM's survival guidance, also quoted below. If you file one long plan to the far end of the triangle, nobody starts looking for you until a half hour after your final ETA. File leg by leg, and the safety net tightens to each stop.

At each intermediate airport, the cycle repeats in miniature. Close the plan for the leg you just finished. Check fuel against your log. Activate the plan for the next leg after departure. The habit pattern you built in Lesson 13 now has to run three times without your instructor prompting it.

> *“When a stopover flight is anticipated, it is recommended that a separate flight plan be filed for each leg of the flight.”*

AIM, Para 5-1-5

> *“For maximum protection, file only to the point of first intended landing, and refile for each leg to final destination.”*

AIM, Para 6-2-6

GROUND MODULE 2-1 · CROSS COUNTRY PLANNING

# FUEL MANAGEMENT ACROSS LEGS

> **SOURCE** 14 CFR 91.151 + PHAK 25C, Ch 16, Fuel Consumption + North Aero Ground Module 2-1 (Cross Country Planning)

Read 91.151 with a multi-leg trip in mind. The rule says no person may begin a flight without fuel to the first point of intended landing plus the reserve, 30 minutes by day and 45 at night at normal cruising speed. Begin a flight is the key phrase. Every departure on this triangle is the beginning of a flight, so the reserve test applies fresh at every stop. You cannot legally launch on leg three with less than destination fuel plus reserve, no matter how the totals looked this morning.

That is why the fuel check at each stop is a task in this lesson, not a courtesy. Compare actual burn against planned burn from your nav log. Groundspeed drives fuel use, so a slower leg than planned means more gallons gone than planned. If the numbers are drifting the wrong way, buy fuel or shorten the plan. The PHAK gives you the backstop: always plan to be on the surface before your flight time exceeds the time you computed for your fuel, and before the gauge shows low fuel.

One planning detail ties this to the paperwork. The endurance block on the flight plan form is the usable fuel on board expressed in time. That number tells search and rescue how long you can stay airborne. Keep it honest at every leg.

> *“No person may begin a flight in an airplane under VFR conditions unless (considering wind and forecast weather conditions) there is enough fuel to fly to the first point of intended landing and, assuming normal cruising speed— (1) During the day, to fly after that for at least 30 minutes; or (2) At night, to fly after that for at least 45 minutes.”*
>
> 14 CFR 91.151(a)

# LOST PROCEDURES: CLIMB, COMMUNICATE, FIX YOUR POSITION

**SOURCE** PHAK 25C, Ch 16, Lost Procedures + AIM, Para 6-2-1 and 6-2-2

Your instructor will make you lost on purpose today, because the real thing is dangerous, especially when fuel is low. The PHAK's opening, quoted below, gives you the first move: climb, while watching for traffic and weather. Altitude increases radio and navigation reception range and increases radar coverage. From higher up, you may also spot a town, and sometimes the town's name is painted on a water tower.

Next, fix your position with whatever is on board. With a VOR receiver, plot an azimuth from two or more stations and you have a position. With GPS, panel or portable, read the position and the nearest airport directly. Hold your last known heading while you work. Random turns destroy the one piece of information you still have.

Then communicate. Use any facility with frequencies shown on the sectional. A controller who can see you on radar may offer vectors. Some facilities can take direction finding steps using your transmissions. The AIM adds the honest safeguards: radar assistance is advisory, flying the airplane safely remains your job, and you must keep the controller told about the weather you are in and the weather ahead. If staying VFR is possible, a non-instrument-rated pilot should choose the VFR option every time, as the quote below directs. Ask for help early, while fuel and daylight are still on your side. In a distress or urgency situation, squawk 7700, because that code normally triggers an alarm at every radar control position.

> *“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.”*
>
> PHAK 25C, Ch 16, Lost Procedures

> *“If a course of action is available which will permit flight and a safe landing in VFR weather conditions, noninstrument rated pilots should choose the VFR condition rather than requesting a vector or approach that will take them into IFR weather conditions”*
>
> AIM, Para 6-2-1

**GROUND MODULE 2-1 · CROSS COUNTRY PLANNING**

# DIVERSION: THE REAL PICKLE, APPLIED

> **SOURCE** PHAK 25C, Ch 16, Flight Diversion + North Aero Ground Module 2-1 (Cross Country Planning)

You first practiced turning toward a better option back in the Real Pickle. Now the skill gets its full cross-country form. Simulated weather will block a leg, and you will divert to an alternate airport with the chart balanced on your knee.

The PHAK's method trades precision for speed, on purpose. In flight it is rarely practical to plot a new course line and measure it. Instead, approximate the course to the alternate using the compass rose around a nearby VOR, or an airway that roughly parallels the way there. Watch one trap: the radial printed on a compass rose points outbound from the station. If you are heading to the station, fly the reciprocal. If time permits, start the diversion over a prominent ground feature so your starting fix is solid.

But do not let neatness delay the turn. The PHAK's warning, quoted below, is the heart of this section. Turn first. Once established on course to the alternate, note the time, apply the winds aloft you already have, and work out a groundspeed. From groundspeed come the new arrival time and the fuel required, which you check against fuel on board. Pick the diversion altitude with cloud heights, winds, terrain, and radio reception in mind. Through all of it, fly the airplane first and divide your attention deliberately.

> *“However, in an emergency, divert promptly toward your alternate destination. Attempting to complete all plotting, measuring, and computations involved before diverting to the alternate destination may only aggravate an actual emergency.”*
>
> PHAK 25C, Ch 16, Flight Diversion

## NON-TOWERED AIRPORTS ALONG THE WAY

**SOURCE** AC 90-66C, Non-Towered Airport Flight Operations

At least one stop today has no operating control tower, and the traffic there manages itself. AC 90-66C is the FAA's playbook for these fields. The communication rule of thumb: all traffic within 10 miles of a non-towered airport should monitor and communicate on the designated CTAF, and inbound aircraft should self-announce position and intentions when entering within 10 miles. A self-announcement includes your aircraft type and call sign, position, altitude, and intention. One phrase is banned outright, as the first quote shows: any traffic in the area, please advise is not a recognized phrase and should not be used under any condition.

Pattern procedure is standardized for the same reason. Unless the airport establishes otherwise, the traffic pattern altitude for propeller-driven aircraft is 1,000 feet above the airport surface, and a common altitude is the key to seeing and avoiding each other. Enter the downwind at a 45 degree angle abeam the midpoint of the landing runway, at pattern altitude, level, with time to see the whole pattern before joining. Descending into the pattern is dangerous because one airplane can settle onto another. All turns are to the left unless the airport displays markings or the Chart Supplement says right traffic.

Straight-in approaches deserve their own caution, quoted below. The FAA prefers the full pattern at these fields. A pilot who does fly a straight-in gets no priority for it and still owes the right-of-way rules to everyone in the pattern. Expect no-radio aircraft too. Nothing at a non-towered field requires a radio, so your eyes stay primary even when the frequency sounds quiet.

> *“Pilots are reminded that the use of the phrase “ANY TRAFFIC IN THE AREA, PLEASE ADVISE” is not a recognized self-announce position and/or intention phrase and should not be used under any condition.”*
>
> AC 90-66C, Para 9.8.1

> *“Pilots choosing to execute a straight-in approach do not have a particular priority over other aircraft in the traffic pattern and must comply with the provisions of § 91.113(g).”*
>
> AC 90-66C, Para 9.11.1

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**GROUND MODULE 2-4 · AIRSPACE APPLIED**

## AIRSPACE TRANSITIONS ON COURSE

**SOURCE** PHAK 25C, Ch 15, Airspace + North Aero Ground Module 2-1 (Cross Country Planning)

A triangle this size will cross airspace boundaries, and each class has its own entry ticket. Class B surrounds the busiest airports, surface to 10,000 feet MSL in tailored layers. The requirement is quoted below: a clearance, in those words, before you enter. Two-way radio and an altitude-reporting transponder are required equipment, and ADS-B Out applies in the airspace described in 91.225.

Class C runs from the surface to 4,000 feet above the airport elevation, usually a five mile surface ring and a ten mile shelf. Class D runs from the surface to 2,500 feet above airport elevation around smaller towered fields. For both, the ticket is the same and it is not a clearance. It is two-way radio communications, established with the controlling facility before you enter and maintained the whole time you are inside, exactly as the second quote below requires.

Class E is all the controlled airspace that is not A, B, C, or D. Most of your enroute cruising happens there, with no entry requirement for VFR, just the weather minimums. In most areas its base is 1,200 feet AGL, elsewhere 700 feet AGL or the surface. Class G is the uncontrolled leftover beneath it. The practical habit: before each leg, run your finger along the course line and name every airspace you will touch, its floor, its ceiling, and its ticket. That is exactly the check you learned while charting the course, now done at three legs' scale.

> *“ATC clearance is required for all aircraft to operate in the area, and all aircraft that are so cleared receive separation services within the airspace.”*
>
> PHAK 25C, Ch 15, Class B Airspace

> *“Each aircraft must establish two-way radio communications with the ATC facility providing air traffic services prior to entering the airspace and thereafter must maintain those communications while within the airspace.”*
>
> PHAK 25C, Ch 15, Class C Airspace

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**GROUND MODULE 2-3 · WEATHER SERVICES AND GO/NO-GO**

## WEATHER ADVISORIES WHILE YOU FLY

> **SOURCE** AIM, Para 7-1-6, Inflight Aviation Weather Advisories + AWH FAA-H-8083-28B, Ch 3

Your morning briefing ages while you fly, and on a three leg trip it ages three times over. Inflight weather advisories are the system's way of reaching you with hazards that develop en route. There are four types: the SIGMET, the Convective SIGMET, the AIRMET, and the Center Weather Advisory. Know what each one is telling you.

A SIGMET, defined in the first quote, is the serious non-convective warning. Over the contiguous United States it covers severe icing, severe or extreme turbulence, widespread dust or sandstorms cutting visibility below 3 miles, and volcanic ash. Convective SIGMETs cover the thunderstorm family: severe thunderstorms, embedded thunderstorms, and lines. The second quote carries the punchline every VFR pilot should memorize: any Convective SIGMET implies severe or greater turbulence, severe icing, and low-level wind shear.

AIRMETs, defined in the third quote, describe the same kinds of phenomena at intensities below SIGMET level, and they are aimed especially at VFR pilots and lighter aircraft. They cover IFR conditions, mountain obscuration, moderate icing, freezing levels, moderate turbulence, strong surface winds, and low-level wind shear potential. A moderate hazard for a jet can be a genuine problem for a trainer, so treat AIRMETs as personal. The CWA is the short-fuse cousin: not a flight planning product, but a nowcast for roughly the next two hours. In the airplane, these advisories reach you through Flight Service frequencies and FIS-B displays. When one touches your route, the go or no-go question reopens in flight, and diverting early beats pressing on.

> *“A SIGMET is a concise description of the occurrence or expected occurrence of specified en route weather phenomena which is expected to affect the safety of aircraft operations.”*
>
> AIM, Para 7-1-6, SIGMET

> *“Any convective SIGMET implies severe or greater turbulence, severe icing, and low-level wind shear.”*
>
> AIM, Para 7-1-6, Convective SIGMET

> *“AIRMETs are a concise description of the occurrence or expected occurrence of specified en route weather phenomena that may affect the safety of aircraft operations, but at intensities lower than those which require the issuance of a SIGMET.”*
>
> AIM, Para 7-1-6, AIRMET

## FLIGHT FOLLOWING: A SECOND SET OF EYES, NOT A GUARANTEE

> **SOURCE** AIM, Para 4-1-15, 4-1-16, and 4-1-17

You will be on radar flight following for this entire flight, so understand exactly what you bought. Radar traffic information service means a controller advises you of radar targets that may come close to your position or route. The quote below is the fine print: the service never relieves you of see and avoid. Advisories come in

clock positions, like traffic, ten o'clock, three miles, and the clock is based on your track, not your nose. In a strong crab, look a little off the called position.

The service is workload permitting. Radar limits, traffic volume, frequency congestion, and controller workload can all end it, and the controller does not have to justify that to you. While receiving the service, monitor the assigned frequency at all times, tell the controller before you change frequencies, and tell the controller when you change your VFR cruising altitude. When you leave the service, expect to be told radar service is terminated, then squawk 1200.

Two more services ride along. A safety alert comes when the controller sees you in unsafe proximity to terrain, obstructions, or another aircraft, and what you do with it is your call. Radar vectors are available to VFR aircraft on request, but the guidance is advisory, and flying the airplane safely remains with you. This is also the connection to the lost procedures section: the same facility giving you advisories is the one that will help you find yourself. Being on frequency before trouble starts is the cheapest insurance on this flight.

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

**LESSON 14 · DUAL TRIANGULAR CROSS-COUNTRY**

# *REVIEW QUESTIONS*

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

1. Why does the AIM recommend a separate flight plan for each leg of a stopover cross-country?
2. How does 91.151 apply at each stop of a triangular cross-country?
3. Your fuel burn on leg one came out higher than planned. What do you check and what are your options?
4. You are lost. What is the first action the PHAK gives, and why?
5. What help can ATC give a lost VFR pilot, and what is the limit of that help?
6. In a diversion, how do you get a course to the alternate without plotting, and what do you compute once established?
7. When should you begin communicating at a non-towered airport, and what belongs in a self-announcement?
8. Does a straight-in approach give you priority at a non-towered field?
9. State the entry requirement for Class B, Class C, and Class D airspace.
10. Where does most of your enroute cruising happen, and what is the entry requirement there?
11. What does any Convective SIGMET imply, and how does an AIRMET differ from a SIGMET?
12. You are on flight following. Does that relieve you of traffic responsibility, and what do you owe the controller?

**LESSON 15** · **PAIRS WITH GROUND MODULE 2-2 (PERFORMANCE) + PHASE 1 MODULE 5 (REVIEW)**

# *Short/Soft Field, Emergency Procedures, XC Emergencies*

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*This flight tightens two skill sets at once. Your short-field and soft-field work moves to near-ACS standard, with the performance charts doing the planning before the wheels do the proving. Your emergency work moves from introduction to standard: the emergency descent, the simulated engine failure, and the cross-country scenarios that Phase 2 makes real. This chapter reviews what Lessons 4, 5, 8, 10, and 12 built, then deepens it to the tolerances you will be graded on.*

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

## Wheels to Wings, Wings to Wheels

*The soft-field logic in one line: who carries the weight, and when.*

Takeoff: transfer the weight from the wheels to the wings as rapidly as possible, then accelerate in ground effect.

Landing: let the wings carry the weight as long as practical, touching down at the lowest possible airspeed, nose high.

Either direction, the goal is the same: keep load off the gear while the surface can hurt it.

North Aero packaging of FAA-S-ACS-6C PA.IV.C.S8 + AFH 3C, Ch 9, Soft-Field Approach and Landing

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

## No Float Means Right Speed

*The short-field energy self-check, applied in the flare.*

A lack of floating during the flare, with enough control to touch down properly, verifies the approach speed was correct.

Float means extra speed, and extra speed spends your stopping distance beyond the aiming point.

Fly 1.3 VSO or the POH speed, plus half the gust factor at most, and the float takes care of itself.

North Aero packaging of AFH 3C, Ch 9, Short-Field Approach and Landing

**GROUND MODULE 2-2 · PERFORMANCE AND LIMITATIONS**

## THE PERFORMANCE CHART COMES FIRST

**SOURCE** North Aero Ground Module 2-2 (Performance and Limitations) + AFH 3C, Ch 6, Prior to Takeoff

A short field is decided at the table, not on the runway. 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 cuts engine and propeller performance, stretches the takeoff roll, and flattens the climb.

Density altitude is pressure altitude corrected for nonstandard temperature. Four things raise it: high temperature, high elevation, high humidity, and low barometric pressure. You can estimate it in two steps. First find pressure altitude: for every 0.01 inch of mercury the altimeter setting sits below 29.92, add about 10 feet to field elevation. Then add roughly 120 feet for each degree Celsius the temperature sits above standard. The POH chart or a flight computer gives the precise number.

Now use it. Enter the takeoff chart at your actual weight and actual density altitude. Read the ground roll and the 50-foot obstacle distance. Compare them to the runway you actually have, for the specific runway you will use. Then check the climb rate against whatever sits off the departure end. The accident pattern in the NTSB record is consistent: the pilot accepts published numbers without correcting for the day. The chart says a 500-foot roll, the pilot expects 500 feet, and the hot-day reality is 800. If the margins are thin, depart earlier in the day, carry less, or wait.

Your airplane's numbers come only from its own POH, and this workbook reproduces none of them on purpose, so bring the airplane's copy to the preflight discussion.

The quick-math numbers in this section are North Aero teaching rules of thumb from Ground Module 2-2. The chart in the POH is always the authority.

# SOFT-FIELD TAKEOFF AND CLIMB

> **SOURCE** AFH 3C, Ch 6, Soft/Rough-Field Takeoff and Climb + FAA-S-ACS-6C, Task PA.IV.C

Tall grass, sand, mud, and snow all drag on the wheels. The soft-field solution is to make the wings carry the airplane as early as possible. Set flaps if the manufacturer recommends them. Keep the airplane moving while you line up, because stopping on a soft surface can bog you down. Then apply power smoothly and as rapidly as the engine will accept.

As the airplane accelerates, hold enough back-elevator for a positive angle of attack. In a nosewheel airplane, that lightens the nosewheel and cuts the drag of surface irregularities. Held in that nose-high attitude, the airplane virtually flies itself off, below a safe climb speed, floating on ground effect. That is the trap and the technique at once. Gently lower the nose and accelerate while still in ground effect. Climb out too early and the airplane can settle back to the surface with full power applied.

After a positive rate at VY, retract gear and flaps as equipped. If an obstacle waits, climb at VX until it is cleared, then transition. Common errors: too little back-elevator early in the roll, climbing out of ground effect before reaching climb speed, abrupt pitch changes while leveling in ground effect, and letting the airplane settle back on.

Fleet note: the AFH chapter describes nosewheel technique. Tailwheel control positioning differs, and it comes from AFH Chapter 14, your airplane's POH, and your instructor. The principle is the same in both: protect the gear, and move the weight from wheels to wings early.

> *“Establish and maintain a pitch attitude that transfers the weight of the airplane from the wheels to the wings as rapidly as possible.”*
>
> FAA-S-ACS-6C, PA.IV.C.S8

> *“Therefore, it is essential that the airplane remain in ground effect until at least VX is reached.”*
>
> AFH 3C, Ch 6, Soft/Rough-Field Takeoff and Climb, Lift-Off

# SOFT-FIELD APPROACH AND LANDING

> **SOURCE** AFH 3C, Ch 9, Soft-Field Approach and Landing + FAA-S-ACS-6C, Task PA.IV.D

The soft-field landing reverses the takeoff logic: keep the wings working as long as practical. The approach looks like a normal one, flown at the same speed you would use for a short field. The difference is power. Carry a degree of power through the level-off and touchdown, letting the airspeed bleed off while the airplane floats 1 to 2 feet above the surface in ground effect. When the main wheels first touch, the wings are still carrying much of the weight.

In a nosewheel airplane, hold the nosewheel off after the mains touch, then use elevator and power to control how fast the weight transfers from wings to wheels. Once committed, lower the nosewheel gently, remembering that a slight addition of power helps ease it down. Stay off the brakes, because the surface slows you and braking can drive the nosewheel in. On a very soft field, you may need power just to keep the airplane moving. Flaps help you touch down at minimum speed, though on a low-wing airplane they can catch mud and stones, and retracting them during rollout is generally unwise.

Common errors: excessive descent rate or airspeed on final, rounding out too high, poor power management through touchdown, a hard touchdown, uncontrolled weight transfer, and letting the nosewheel fall instead of flying it down.

> *“Touchdown on a soft or rough field is made at the lowest possible airspeed with the airplane in a nose-high pitch attitude.”*
>
> AFH 3C, Ch 9, Soft-Field Approach and Landing

> *“Make smooth, timely, and correct control inputs during the round out and touchdown, and, for tricycle gear airplanes, keep the nose wheel off the surface until loss of elevator effectiveness.”*
>
> FAA-S-ACS-6C, PA.IV.D.S9

# SHORT FIELD TO NEAR-ACS TOLERANCE

**SOURCE** AFH 3C, Ch 9, Short-Field Approach and Landing + FAA-S-ACS-6C, Tasks PA.IV.E and PA.IV.F

Lesson 12 introduced the technique. Today you measure it. On the takeoff side, the standard is obstacle clearance speed or VX, plus 10 or minus 5 knots, held until the obstacle is cleared or 50 feet, then VY to a safe altitude. On the approach, the same plus 10 or minus 5 tolerance applies to your approach speed.

The landing standard has two halves. Speed: minimum controllable airspeed at touchdown, in about the pitch attitude that would produce a power-off stall if the throttle were closed. Place: on or within 200 feet beyond your specified point, no side drift, minimum float, aligned with the centerline. The AFH gives you the self-check that links them. A lack of floating during the flare, with enough control to touch down properly, is verification that the approach speed was correct. Float means you carried extra speed, and extra speed spends your stopping distance.

After touchdown, hold the pitch attitude for aerodynamic braking as long as the elevator works, if the manufacturer recommends it, then apply brakes smoothly with the wheel or stick held full back. Aerodynamic drag does most of the early slowing, and the brakes take over as lift decays. If the approach was flown on speed, heavy braking should not be needed. And the rule from Lesson 12 still stands: any doubt about the outcome, go around and reset.

> *“Maintain manufacturer’s published approach airspeed or in its absence not more than 1.3 VSO, +10/-5 knots with gust factor applied.”*
>
> FAA-S-ACS-6C, PA.IV.F.S7

> *“A lack of floating during the flare with sufficient control to touch down properly is verification that the approach speed was correct.”*
>
> AFH 3C, Ch 9, Short-Field Approach and Landing

# EMERGENCY DESCENT, FLOWN TO STANDARD

**SOURCE** AFH 3C, Ch 18, Emergency Descents (reviewed from Vol 1, Lesson 4)

You met the emergency descent in Lesson 4. Today it gets flown to standard, because a fire or smoke in the cockpit does not grade on a curve. The maneuver exists to trade altitude for time on the ground as fast as the airframe safely allows.

The Phase 1 procedure still governs, and your POH always wins on specifics. Unless the manufacturer says otherwise: power to idle, propeller to low pitch as applicable. Configure 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, which keeps a positive load on the airplane and lets you clear the airspace below as you spiral. Plan the recovery with enough altitude to level off or land.

Fly it crisply and talk through it as you go: what failed, what speed limit applies to this configuration, where the descent ends. Your instructor grades this against ACS Emergency Operations Task A, so treat every rep as the checkride rep.

> *“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

**PHASE 1 MODULE 5 (REVIEW)**

# CROSS-COUNTRY EMERGENCIES

> **SOURCE** AFH 3C, Ch 18, Emergency Landings + Psychological Hazards (reviewed from Vol 1, Lesson 4)

Phase 2 moves your emergencies away from home. The definitions from Lesson 4 now carry route-level weight. A forced landing is an immediate landing, on or off an airport, because further flight is impossible. A precautionary landing is a premeditated landing while flight is still possible but inadvisable. On a cross-country, the precautionary landing is the smart pilot's tool: deteriorating weather, being lost, fuel running thin, or an engine running rough are all reasons to land early, at an airport of your choosing, while every option is still open.

The psychology has not changed. The AFH names three 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 keep flying speed and committing to the best field within reach. The physics has not changed either. Destructive energy rises with the square of groundspeed. A touchdown at the lowest possible controllable airspeed, under control, beats a perfect field reached fast. The airplane is dispensable. The cabin is not.

Today's scenarios connect those pieces in flight: a simulated engine failure, a systems malfunction mid-leg, and the decision of forced versus precautionary. Answer each one out loud, choose, and fly the choice.

> *“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

# EMERGENCY EQUIPMENT AND SURVIVAL GEAR

**SOURCE** North Aero PP Syllabus 5.1, Lesson 15 + 14 CFR 91.205(b)

Today's preflight has a second agenda: put your hands on every piece of emergency equipment aboard. Find the ELT and know how it activates, find the fire extinguisher and know how to release and aim it, and know where the first aid kit rides and how the doors and belts release. An emergency is the wrong time to search the baggage area.

Regulation sets the floor. The 91.205(b) day-VFR list includes an approved safety belt for each occupant, and shoulder harnesses for the seats of most airplanes built after the late 1970s. An emergency locator transmitter is required when 91.207 says so. And the rule below covers flights for hire over water. Beyond the floor, what you carry is judgment: think about the terrain and the season along each cross-country route, and talk the kit through with your instructor during the preflight discussion.

The checkride will treat this as its own task, Emergency Equipment and Survival Gear. Build the habit now: every airplane, every flight, know what is aboard, where it is, and how it works.

> *“If the aircraft is operated for hire over water and beyond power-off gliding distance from shore, approved flotation gear readily available to each occupant and, unless the aircraft is operating under part 121 of this subchapter, at least one pyrotechnic signaling device.”*
>
> 14 CFR 91.205(b)(12)

**LESSON 15 · SHORT/SOFT FIELD, EMERGENCY PROCEDURES, XC EMERGENCIES**

# *REVIEW QUESTIONS*

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

1. Define density altitude and name the four factors that raise it.
2. The altimeter setting is 29.72 and field elevation is 300 feet. Estimate pressure altitude, and describe the next step to estimate density altitude.
3. Why must the airplane stay in ground effect after a soft-field liftoff, and until what speed?
4. What makes the soft-field landing different from a normal landing, and why do you stay off the brakes?
5. State the ACS touchdown standard for a short-field landing.
6. How do you verify your short-field approach speed was correct, per the AFH?
7. Describe the emergency descent configuration and its speed and bank limits.
8. On a cross-country, what separates a forced landing from a precautionary landing, and which one preserves more options?
9. Name the three psychological traps in an emergency landing and the physics rule that sets touchdown priorities.
10. When does 14 CFR 91.205(b) require flotation gear, and what must come with it?

**LESSON 16** · **PAIRS WITH GROUND MODULE 2-5**

# *Night Flight: Local Area and Landings*

*Tonight the airport you know by heart becomes a new place. This flight covers night preflight, taxi, takeoffs, pattern work, landings, and a go-around, plus your first solo night landings. This chapter gives you the three legal definitions of night, how your eyes work in the dark, the illusions that bend a night approach, and the lighting language airports speak after sunset.*

**MEMORY AID** · **FAA**

## The Three Nights

*Three regulatory night windows, opening in order every evening.*

Lights night: 91.209. Position lights on from sunset to sunrise.

Logging night: 14 CFR 1.1. Night time logs from the end of evening civil twilight to the beginning of morning civil twilight.

Currency night: 61.57(b). Passenger-carrying currency needs 3 full-stop takeoffs and landings, within 90 days, made 1 hour after sunset to 1 hour before sunrise.

Order each evening: lights at sunset, logging at end of civil twilight, currency window 1 hour after sunset.

14 CFR 1.1 + 61.57(b) + 91.209

**MEMORY AID** · **FAA**

## Night Vision Numbers

*The numbers that run your eyes in the dark.*

30 minutes: maximum dark adaptation time.

1 second: a bright light held this long or more undoes dark adaptation.

5 to 10 degrees: the central night blind spot. Use off-center viewing and keep the scan moving.

5,000 feet: above this at night, flight without supplemental oxygen can bring vision-impairing hypoxia.

AFH 3C, Ch 11, Night Vision

**MEMORY AID · FAA**

### 7-5-3 and 15

*Pilot-controlled lighting by microphone click.*

7 clicks within 5 seconds: highest intensity. Always key 7 first.
5 clicks: medium or lower intensity.
3 clicks: lowest intensity.
15 minutes: how long the lights stay on from the most recent activation.

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

**GROUND MODULE 2-5 · NIGHT OPERATIONS**

## WHAT COUNTS AS NIGHT: THREE DEFINITIONS

**SOURCE** 14 CFR 1.1 + 14 CFR 61.57(b) + AFH 3C, Ch 11, Introduction

In the regulations, night is three separate windows, and each window controls a different privilege. Learn all three now, because examiners raise these distinctions on almost every checkride. They matter on every evening flight.

The first window defines night itself, and it controls when you log night flight time. Under 14 CFR 1.1, night runs from the end of evening civil twilight to the start of morning civil twilight. The Airplane Flying Handbook explains the boundary: evening civil twilight begins at sunset and ends when the geometric center of the sun is 6 degrees below the horizon. The FAA has an online tool that calculates sunrise, sunset, and civil twilight for any location.

The second window controls carrying persons. For 61.57(b) night currency, the period runs from 1 hour after sunset to 1 hour before sunrise. To act as pilot in command with passengers in that window, you need three takeoffs and three landings to a full stop. They must be made within the preceding 90 days, during that same window, as sole manipulator, in the same category, class, and type (if a class or type rating is required).

The third window controls aircraft lights, because 91.209 requires position lights from sunset to sunrise. Notice the sequence on any evening: lights come on first at sunset, logging starts at the end of civil twilight, and the currency window opens 1 hour after sunset.

Notice the word in the rule: persons, not passengers. The FAA rewrote 61.57 in 2024, and the new word covers everyone aboard who is not a required crewmember. Say it the way the rule says it.

> *“Night means the time between the end of evening civil twilight and the beginning of morning civil twilight, as published in the Air Almanac, converted to local time.”*
>
> 14 CFR 1.1

> *"no person may act as pilot in command of an aircraft carrying persons during the period beginning 1 hour after sunset and ending 1 hour before sunrise, unless within the preceding 90 days that person has made at least three takeoffs and three landings to a full stop during the period beginning 1 hour after sunset and ending 1 hour before sunrise"*
>
> 14 CFR 61.57(b)(1)

**GROUND MODULE 2-5 · NIGHT OPERATIONS**

## YOUR EYES AT NIGHT

**SOURCE** AFH 3C, Ch 11, Night Vision

The AFH opens its night chapter with a memorable point: the airplane does not know it is dark. The machine performs identically at night and responds to the same control inputs. The pilot is the component that changes, and the change starts in the eye.

Two kinds of photosensitive cells line the retina. Cones fill the central area and handle detail, color, and distant objects in good light, while rods live mainly in the periphery and handle dim light. When normal light is gone, night vision operates almost entirely on the rods.

The exact center of your eye contains cones only, and that absence of rods creates a night blind spot covering the central 5 to 10 degrees of your visual field. Stare directly at a dim object at night and it can go undetected, or fade after detection. The remedy is off-center scanning: keep your eyes moving, and look slightly to the side of whatever you want to see.

Your eyes also need time to adjust, because dark adaptation builds gradually and disappears quickly. A bright light source held for 1 second or more will undo it, while aircraft anti-collision flashes do no harm, because each flash lasts under 1 second. If it is safe, close one eye during bright exposure to preserve its adaptation.

Protect the whole system. At night, flight above 5,000 feet without supplemental oxygen can produce hypoxia, which impairs visual performance. Self-medication, alcohol, tobacco, low blood sugar, and fatigue all degrade night vision. Red flight deck lighting preserves dark adaptation but distorts chart colors, so keep dim white light available for reading charts and instruments.

> *"In darkness, vision gradually becomes more sensitive to light. Maximum dark adaptation can take up to 30 minutes."*
>
> AFH 3C, Ch 11, Vision Under Dim and Bright Illumination

GROUND MODULE 2-5 · NIGHT OPERATIONS

# NIGHT ILLUSIONS

> **SOURCE** AFH 3C, Ch 11, Night Illusions + How to Prevent Landing Errors Due to Optical Illusions

Darkness makes your eyes easy to fool, and at night you steer by your eyes. Two illusions attack your orientation directly. A false horizon appears when ground lights blend with stars, or when a sloping cloud formation looks level, and you can align the airplane with the wrong line without feeling the error. The second is autokinesis, which targets any single light you stare at.

The approach illusions are the ones that bend final. The most famous is the black-hole approach over water or unlighted terrain, where missing peripheral cues make the runway seem to slope, and the worst case is landing short. Bright runway lighting with dark surroundings can make you feel low or close, so you tend to fly a higher approach. Sparse ground lighting can make the runway seem farther away, pulling you into a lower one.

The AFH's prevention list is plain. Anticipate illusions at unfamiliar airports at night. Review runway slope, terrain, and lighting in the airport diagram and Chart Supplement before the approach. Reference the altimeter frequently, and use a VASI, PAPI, or electronic glideslope whenever one is available. Any time your position or altitude relative to the runway is in doubt, go around.

> *“In the dark, a stationary light will appear to move about when stared at for many seconds. The disoriented pilot could lose control of the aircraft in attempting to align it with the false movements of this light.”*
>
> AFH 3C, Ch 11, Autokinesis

> *“A black-hole approach occurs when the landing is made from over water or non-lighted terrain where the runway lights are the only source of light.”*
>
> AFH 3C, Ch 11, Featureless Terrain Illusion

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GROUND MODULE 2-5 · NIGHT OPERATIONS

# RULES, FUEL, AND REQUIRED EQUIPMENT

> **SOURCE** 14 CFR 91.209 + 91.151(a) + 61.109(a)(2) + AFH 3C, Ch 11, Pilot Equipment and Airplane Equipment and Lighting

The lights rule is 91.209: from sunset to sunrise, you may not operate an aircraft unless its position lights are on. The arrangement matches boats and ships, with red on the left wingtip, green on the right wingtip, and white on the tail. That pattern lets you read another airplane's direction of movement. Red on its left

and green on its right means it is flying your direction. Red on the right and green on the left could mean a collision course.

The AFH points to 91.205(c) for the basic equipment required for night VFR, including an approved anti-collision light system. Under 91.209(b), the pilot in command may turn the anti-collision lights off when conditions make that the safer choice. Landing lights help others see you, and pilots are encouraged to use them within 10 miles of an airport and below 10,000 feet, day or night.

Fuel reserves grow at night. Under 91.151, a VFR airplane flight must carry enough fuel to reach the first point of intended landing, considering wind and forecast weather, plus a reserve at normal cruising speed: at least 30 minutes during the day, and at least 45 at night.

For awareness, 61.109(a)(2) sets your night experience for the private certificate: 3 hours of night flight training, including one cross-country over 100 nautical miles and 10 takeoffs and 10 landings to a full stop, each with a flight in the traffic pattern. Tonight starts that work.

Personal equipment matters more at night. Carry at least one reliable flashlight with spare batteries; a dimmable light with white and red modes covers preflight, flight deck work, and chart reading. Bring the charts you need, including the adjacent chart if your course runs near an edge, and organize everything within reach before you taxi.

> *“During the period from sunset to sunrise (or, in Alaska, during the period a prominent unlighted object cannot be seen from a distance of 3 statute miles or the sun is more than 6 degrees below the horizon)”*
>
> 14 CFR 91.209(a)

> *“Operate an aircraft unless it has lighted position lights;”*
>
> 14 CFR 91.209(a)(1)

> *“At night, to fly after that for at least 45 minutes.”*
>
> 14 CFR 91.151(a)(2)

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**GROUND MODULE 2-5 · NIGHT OPERATIONS**

## READING THE AIRPORT AT NIGHT

> **SOURCE** AIM, Ch 2, Sec 1, Airport Lighting Aids + AFH 3C, Ch 11, Airport and Navigation Lighting Aids

You will identify airports at night by their beacons. A lighted civil land airport flashes alternating white and green, while a lighted water airport flashes white and yellow. A military airport also flashes white and green, but with dual peaked, two quick, white flashes between the green ones. A lighted heliport shows green,

yellow, and white, and beacons flashing red mark obstructions or areas hazardous to flight.

A beacon running in daylight is a warning. The AIM notes there is no regulatory requirement for daylight beacon operation, so never rely on the beacon alone; check the reported weather before entering that airspace.

The runway speaks in color. Edge lights are white, though on instrument runways yellow replaces white on the last 2,000 feet or half the runway, whichever is less, as a caution zone. The lights across the runway ends show green toward landing aircraft at the threshold, and red toward a departing aircraft at the far end. Taxiway edge lights are blue. REILs, a pair of synchronized flashing lights at the threshold, mark the approach end when the runway is hard to pick out. VASI and PAPI give red over white glide path guidance you will lean on at night.

Many airports let you control the lighting by radio. Key the microphone 7 times within 5 seconds for the highest intensity, 5 times for medium, and 3 times for low; the lights run for 15 minutes from the most recent activation. Always key 7 times first, even if the lights already look on, so you get full intensity and a fresh 15 minutes. The activation frequency is listed in the Chart Supplement. Before any night flight, check the destination's lighting and read the NOTAMs for outages.

> *“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 2-5 · NIGHT OPERATIONS**

# FLYING THE LESSON: PREFLIGHT THROUGH LANDING

> **SOURCE** AFH 3C, Ch 11, Preparation and Preflight through Approaches and Landings

Night preflight starts with weather, and one number pair matters most: a narrow temperature and dew point spread may indicate fog. Give wind direction and speed extra attention too, because the wind's effect on the airplane is harder to detect at night. During the walkaround, turn each aircraft light on momentarily to confirm operation, and tap the position light fixtures; a blinking light means a loose connection to resolve before flight. Sweep the ramp with your flashlight before moving, because chocks and stepladders hide at night.

Clear the propeller area slowly and methodically before start, and turn the beacon on to warn anyone nearby. Taxi slowly and follow the painted lines. During the runup, hold or lock the brakes and watch for creep, because a night airplane can roll forward without you noticing. Before taking the runway, confirm that your position, taxi route, and departure runway all match what you expect. If anything conflicts, stop, because a wrong-surface takeoff at night can be catastrophic.

On takeoff, dim the flight deck lighting to the minimum that still lets you read the instruments. Line up on the centerline, confirm the heading indicator matches the runway direction, and advance the throttle smoothly, checking the instruments frequently for airspeed, attitude, and heading. After liftoff, verify a positive climb on the attitude indicator, VSI, and altimeter, because outside cues will not tell you. Hold best climb speed and delay turns until a safe maneuvering altitude. Without lights ahead, pilots tend to relax right rudder and drift left.

En route, watch for the quiet signs of weather. The first hint of lowering visibility is the gradual disappearance of ground lights. A halo or glow around ground lights indicates ground fog. Turn around while the lights behind you are still sharp.

Fly the approach at day speeds and configuration, and trust the instruments over your impressions. Cross-check the altimeter and VSI constantly on base and final. Identify the runway lights early, keep them in sight, and turn the landing light on about halfway down final. Continue the descent until the landing light shows the runway surface and tire marks clearly; that is your cue to begin the round out. If the landing light fails, start the round out when the far-end runway lights appear to rise above the nose, a blackout technique your instructor will have you practice on purpose.

> *“A low, shallow approach is definitely inappropriate during a night operation.”*

AFH 3C, Ch 11, Approaches and Landings

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**GROUND MODULE 2-5 · NIGHT OPERATIONS**

## NIGHT EMERGENCIES AND YOUR NIGHT SOLO

> **SOURCE** AFH 3C, Ch 11, Night Emergencies + 14 CFR 61.87(o)

The classic worry about single-engine night flying is a complete engine failure. The AFH calls that concern legitimate, then adds perspective: continued flight into adverse weather and poor pilot judgment account for most serious accidents. Your best emergency tool is the discipline to stay out of the corner.

If the engine does fail at night, the sequence is familiar with night-specific additions. Maintain positive control and set best glide. Turn toward an airport or away from congested areas. Check the likely causes: fuel selector position, magneto switch, primer. Announce the emergency to ATC or UNICOM, and do not change frequencies unless told to. If the nearby terrain is known and suitable for a forced landing, turn toward an unlighted portion of the area, close to public access if possible, and stay oriented to the wind to avoid landing downwind. Check the landing lights at altitude and turn them on in time to light the flightpath. Land in the normal attitude at the slowest possible airspeed. If the lights are unusable and there are no outside references, hold a level-landing attitude until the airplane contacts the ground. Then switches off, and evacuate quickly.

One more regulation matters here, because part of tonight is yours alone. Before any student night solo, 61.87(o) requires specific night training and a night solo endorsement for the specific make and model, given within the preceding 90 days. The airport in the regulation is not generic: your training must include night takeoffs, approaches, landings, and go-arounds at the airport where your solo will happen, plus night navigation training in its vicinity.

> *“A student pilot may not operate an aircraft in solo flight at night unless that student pilot has received: (1) Flight training at night on night flying procedures that includes takeoffs, approaches, landings, and go-arounds at night at the airport where the solo flight will be conducted;”*

14 CFR 61.87(o)

> *“(2) Navigation training at night in the vicinity of the airport where the solo flight will be conducted; and”*

14 CFR 61.87(o)(2)

**LESSON 16 · NIGHT FLIGHT: LOCAL AREA AND LANDINGS**

# *REVIEW QUESTIONS*

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

1. Name the three regulatory definitions of night and what each one controls.
2. What does night currency require before you carry persons at night?
3. Why does a dim object disappear when you stare straight at it at night, and what is the fix?
4. How long can maximum dark adaptation take, and what destroys it?
5. What is a black-hole approach and how do you defend against it?
6. What are the position light colors, and when must position lights be on?
7. What fuel reserve does night VFR require?
8. At night you see a beacon with two quick white flashes, then green. What is it?
9. How do you activate pilot-controlled lighting, and how long does it last?
10. What must happen before you fly your night solo?

CHECK YOUR WORK

# ANSWER KEY

## LESSON 12 · INSTRUMENT WORK, COMPASS, UNUSUAL ATTITUDES, SHORT FIELD

1. When the aircraft is straight and level at a constant speed. The compass only reads correctly when its card is horizontal and undisturbed. In turns, banks, and speed changes, dip errors make it lie, so a reset then would copy a false heading into the heading indicator.
2. Variation is the difference between true and magnetic directions. It depends on location, not heading. Deviation is error from the airplane's own magnetic fields and changes with heading. Apply variation to true course to get magnetic course, then apply deviation from the correction card to get compass course.
3. Undershoot North: stop the turn early, before the compass card reaches north, because the card leads on northerly headings. The rule of thumb is 15 degrees plus half your latitude. Near 40 degrees latitude, roll out about 35 degrees before the card shows the target.
4. It shows a false turn toward north even though the heading has not changed. ANDS covers it: Accelerate North, Decelerate South, on easterly and westerly headings. Ignore the indication until you are back at a steady speed.
5. Pitch attitude greater than 25 degrees nose up, pitch attitude greater than 10 degrees nose down, bank angle greater than 45 degrees, or flight within those parameters at airspeeds inappropriate for the conditions.
6. Power to idle. Slight forward pressure to unload to about positive 1G. Roll wings level with coordinated controls. Gently raise the nose after the wings are level and the speed is safe. Add climb power once stabilized. Pulling while banked tightens the spiral, and a rolling pullout can exceed the airplane's design limits.
7. Reduce the angle of attack by pushing until the stall warning stops. Only then roll wings level and add power as needed. Trying to fix the bank before the wing is flying again is a listed error, because roll control returns once the angle of attack is reduced.
8. Use the full runway from the very beginning of the takeoff area, set flaps per the POH, and apply power smoothly. Rotate approaching VX, then hold obstacle clearance speed or VX, plus 10 or minus 5 knots, until the obstacle is cleared or 50 feet. Then accelerate to VY, and retract gear and flaps after a positive rate, flaps in increments.
9. Not more than 1.3 VSO, adding no more than one half the gust factor in gusty air. Touch down at minimum controllable airspeed, on or within 200 feet beyond the specified point, with no side drift and the longitudinal axis aligned with the centerline.

10. You are. The service is workload permitting and never relieves the pilot of see-and-avoid responsibility. Before changing frequencies, advise the controller, and squawk 1200 after the service ends.

## LESSON 13 · FIRST DUAL CROSS-COUNTRY

1. All available information concerning the flight. For a flight not in the vicinity of an airport, that includes weather reports and forecasts, fuel requirements, alternatives if the flight cannot be completed, and known traffic delays. For any flight, it includes runway lengths at airports of intended use and the airplane's takeoff and landing distance data.
2. Choose prominent, easy-to-locate features: large towns, large lakes and rivers, or combinations like a town with an airport and a railroad. On the chart, prefer towns shown as splashes of yellow over towns shown as small circles, which may be only a few houses. Where possible, use features on each side of the course as brackets against drift.
3. Check the course and the areas on either side for airspace you should be concerned about, such as Class B, C, or D. Study terrain and obstructions to find the highest elevation and tallest obstruction. Study the Chart Supplement and NOTAMs for every airport where a landing is intended.
4. Pilotage is navigation by reference to landmarks or checkpoints. Dead reckoning is navigation solely by means of computations based on time, airspeed, distance, and direction. Dead reckoning predicts the heading and groundspeed, and pilotage checks those predictions against checkpoints on the ground.
5. Hold the heading and look for the next checkpoint. Never rely on a single checkpoint. The PHAK warns that turning away from the heading when confused is how pilots become lost.
6. TC plus or minus WCA gives TH. Apply magnetic variation to get MH. Apply compass deviation to get CH. The wind correction angle comes from the wind triangle, variation from the isogonic line on the chart, and deviation from the airplane's compass card.
7. Time equals distance divided by groundspeed. 210 divided by 140 is 1.5 hours, or one hour and thirty minutes.
8. Considering wind and forecast weather, enough fuel to fly to the first point of intended landing and, at normal cruising speed, at least 30 more minutes by day or 45 more minutes at night. Under 91.151(a) you may not begin the flight without it.
9. A magnetic course of zero through 179 degrees takes odd thousands plus 500 feet, such as 3,500, 5,500, or 7,500. The rule keys on magnetic course, the track over the ground, not the heading you hold to correct for wind.
10. No. Weight and CG are separate limits and both must be within bounds. An aft CG makes the airplane less stable and harder to recover from a stall. Shift the load forward, recalculate, and confirm the CG is inside the envelope before flight.
11. Standard, when planning a flight and you have no previous briefing or preliminary online information. Abbreviated, to supplement mass disseminated data, update a

previous briefing, or get one or two specific items. Outlook, when departure is six or more hours away, followed by a standard or abbreviated briefing before departure.

12. You do, both times, with Flight Service or an equivalent filing service. Control towers neither activate nor close VFR flight plans. If the plan is not closed within one half hour after your ETA, search and rescue procedures are started.

## LESSON 14 · DUAL TRIANGULAR CROSS-COUNTRY

1. For maximum search and rescue protection. File only to the point of first intended landing and refile for each leg. If one long plan runs to the final destination, overdue procedures do not start until a half hour after the final ETA, which can leave a downed airplane unlooked-for after an early leg.
2. The rule governs beginning a flight, and every departure begins a flight. So at each stop you must have enough fuel to reach the next point of intended landing plus 30 minutes at normal cruising speed by day, or 45 minutes at night, considering wind and forecast weather.
3. Compare actual burn and groundspeed against the nav log. A slower groundspeed means more fuel per mile. If the trend continues, the remaining legs must be replanned: buy fuel at the stop, shorten the route, or add a fuel stop. Always plan to be on the surface before flight time exceeds the fuel time you computed and before the gauge reads low.
4. Climb, while staying mindful of traffic and weather. Altitude increases radio and navigation reception range and increases radar coverage, which improves every later step: position fixing, communication, and radar help.
5. A controller with radar contact can offer vectors, and some facilities can use direction finding on your transmissions. The assistance is advisory. It does not authorize breaking any regulation, and responsibility for flying the airplane safely stays with the pilot. A non-instrument-rated pilot should choose a VFR course of action over any vector into IFR conditions, and should keep the controller advised of the weather.
6. Approximate the course with the compass rose around a nearby VOR or an airway that parallels the route, remembering that printed radials point outbound from the station. Divert promptly, then note the time, apply known winds aloft, and compute groundspeed, a new arrival time, and fuel required.
7. Monitor and communicate on the CTAF within 10 miles, and self-announce position and intentions when entering within 10 miles. Include aircraft type and call sign, position, altitude, and intention. The phrase any traffic in the area, please advise is not recognized and should never be used.
8. No. AC 90-66C states that pilots choosing a straight-in approach have no particular priority over aircraft in the traffic pattern and must comply with the right-of-way provisions of 91.113(g). The FAA-preferred entry is the 45 degree entry to downwind, at pattern altitude.
9. Class B requires an ATC clearance before entry, plus a two-way radio and an operating transponder with automatic altitude reporting. Class C and Class D

require two-way radio communications established with the controlling ATC facility before entry and maintained while inside the airspace.

10. In Class E, the controlled airspace that is not A, B, C, or D. There is no entry requirement for VFR aircraft, only the VFR weather minimums. Its base is 1,200 feet AGL in most areas, 700 feet AGL or the surface in others, with Class G uncontrolled airspace beneath.
11. Any Convective SIGMET implies severe or greater turbulence, severe icing, and low-level wind shear. An AIRMET describes the same kinds of en route weather at intensities lower than SIGMET criteria, and it is aimed especially at VFR pilots and lighter aircraft, so it deserves full respect in a trainer.
12. No. The service is not intended to relieve the pilot of continual vigilance to see and avoid other aircraft, and it is workload permitting. You owe constant monitoring of the assigned frequency, notice before changing frequencies, and notice when changing your VFR cruising altitude. Squawk 1200 after the service is terminated.

## LESSON 15 · SHORT/SOFT FIELD, EMERGENCY PROCEDURES, XC EMERGENCIES

1. Density altitude is pressure altitude corrected for nonstandard temperature. It rises with high temperature, high elevation, high humidity, and low barometric pressure.
2. 29.92 minus 29.72 is 0.20 inches, and at about 10 feet per 0.01 inch that adds roughly 200 feet. Pressure altitude is about 500 feet. Then add roughly 120 feet per degree Celsius above standard temperature, or use the POH chart or a flight computer for the precise number.
3. The nose-high technique lifts the airplane off below a safe climb speed, so it is flying on ground effect. Climbing out early can make it settle back to the surface even at full power. It must stay in ground effect and accelerate until at least VX is reached.
4. A degree of power is carried through the level-off and touchdown, so the airplane touches at the lowest possible airspeed, nose high, with the wings still carrying much of the weight. Braking is avoided because it loads the nose gear and can dig the nosewheel into the soft surface. The surface itself slows the airplane.
5. Touch down at a proper pitch attitude on or within 200 feet beyond the specified point, threshold markings, or runway numbers, with no side drift, minimum float, and the longitudinal axis aligned with and over the runway centerline.
6. By the absence of float. A lack of floating during the flare, with sufficient control to touch down properly, verifies the approach speed was correct. Float means excess speed, which spends stopping distance.
7. Unless the manufacturer says otherwise: power to idle, propeller to low pitch as applicable, and gear and flaps set per the POH for maximum drag. Never exceed VNE, VLE, or VFE as applicable. Descend in a 30 to 45 degree bank for positive load and traffic scanning, and recover with enough altitude to level off or land.
8. A forced landing is immediate because further flight is impossible, such as engine failure. A precautionary landing is premeditated while flight is still possible but inadvisable, for reasons like weather, being lost, fuel, or rough running. The

precautionary landing preserves more options because you choose the time and place early.

9. Reluctance to accept the emergency, undue concern about getting hurt, and the desire to save the airplane. The physics: destructive energy quadruples when groundspeed doubles, so touch down at the lowest possible controllable airspeed, under control, and let the airplane's structure absorb the energy.
10. When the aircraft is operated for hire over water and beyond power-off gliding distance from shore. Approved flotation gear must be readily available to each occupant, plus at least one pyrotechnic signaling device outside part 121 operations.

## LESSON 16 · NIGHT FLIGHT: LOCAL AREA AND LANDINGS

1. 14 CFR 1.1 defines night as the time between the end of evening civil twilight and the beginning of morning civil twilight; that window controls logging night flight time. 61.57(b) uses 1 hour after sunset to 1 hour before sunrise for passenger-carrying night currency. 91.209 requires lighted position lights from sunset to sunrise.
2. Within the preceding 90 days, three takeoffs and three landings to a full stop, made during the period from 1 hour after sunset to 1 hour before sunrise, as sole manipulator of the controls, in the same category, class, and type (if a class or type rating is required).
3. The center of the retina, the fovea, contains cones only and no rods, so there is a night blind spot covering the central 5 to 10 degrees of the visual field. An object viewed directly may go undetected or fade after detection. The fix is off-center viewing: scan and look slightly to the side of the object.
4. Up to 30 minutes. Exposure to a bright light source for 1 second or more temporarily impairs it. Anti-collision light flashes do not, because each flash lasts less than 1 second. If safe, close one eye during a bright exposure to preserve that eye's adaptation.
5. It occurs when landing from over water or non-lighted terrain where the runway lights are the only source of light. Orientation is difficult, the runway can seem out of position, and the worst case is landing short. Use an electronic glideslope or VASI if available, rely on the flight instruments, and go around any time position or altitude is in doubt.
6. Red on the left wingtip, green on the right wingtip, white on the tail. Under 91.209, no person may operate an aircraft from sunset to sunrise unless it has lighted position lights.
7. Under 91.151, enough fuel to fly to the first point of intended landing, considering wind and forecast weather, and then at night at least 45 minutes more at normal cruising speed. The day reserve is 30 minutes.
8. A lighted military airport. Military beacons flash white and green like civil land airports, but are differentiated by dual peaked, two quick, white flashes between the green flashes. A civil land airport shows a single white flash alternating with green.

9. Key the microphone on the published frequency: 7 clicks within 5 seconds for highest intensity, 5 for medium, 3 for low. Lighting runs 15 minutes from the most recent activation. Always key 7 times first to get full intensity and a fresh 15 minutes, and re-key when inbound so the timer does not run out on final.
10. Under 61.87(o): flight training at night covering takeoffs, approaches, landings, and go-arounds at the airport where the solo will be conducted, navigation training at night in the vicinity of that airport, and a logbook endorsement for night solo in the specific make and model, given by an authorized instructor within the preceding 90 days.

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 12: Aircraft-specific speeds (VX, VY, VSO, approach speeds) and flap settings are POH material and are not reproduced; read the airplane copy.
- Lesson 12: AFH 3C Ch 5 Figure 5-3, the upset recovery template, is a graphic and did not extract as text; nose-high and nose-low guidance here is grounded in the chapter's stall recovery and spiral dive prose instead.
- Lesson 12: The FAA-S-ACS-6C PDF extraction truncated at Area of Operation VII; PA.VIII.D (compass turns) and PA.VIII.E (unusual attitudes) elements were not captured and are not quoted. Area IV tolerances quoted here were captured in full.
- Lesson 12: Tailwheel-specific takeoff and landing technique lives in AFH 3C Ch 14, which was not fetched this session; tailwheel control positioning defers to the POH and instructor.
- Lesson 12: Compass turning error mnemonic standardized as OSUN (Overshoot South, Undershoot North) per the Phase 1 ground checklist; the vol2 spec's UNOS reference is superseded.
- Lesson 13: POH performance, fuel burn, and weight and balance numbers are not reproduced; run the actual figures from the airplane's own AFM/POH copy.
- Lesson 13: PHAK Ch 16 PDF at the primary faa.gov/sites URL returned empty on repeated fetches; the chapter was successfully fetched in full from the faa.gov media URL for the same file and all Ch 16 content here comes from that fetched text.
- Lesson 13: PHAK 25C Ch 16 still illustrates the legacy domestic flight plan form; current filing practice uses FAA Form 7233-4 per AIM 5-1-1 and 5-1-5, and this chapter follows the AIM.
- Lesson 13: Aviation Weather Handbook FAA-H-8083-28B single-PDF fetch truncated within Chapter 3; the briefing and self-briefing content used here was captured in full before the truncation point.
- Lesson 13: The em dash inside the 14 CFR 91.151(a) quote is the regulation's own punctuation, retained per verbatim-quote rules; no em or en dashes appear in chapter prose.
- Lesson 14: Aviation Weather Handbook FAA-H-8083-28B single-PDF fetch truncated within Chapter 3, so the Chapter 26 (Advisories) body text was not captured this session. Advisory content is grounded in the current AIM 7-1-6 and the captured AWH Chapter 3 product tables; re-fetch Chapter 26 before any deeper advisory coverage.
- Lesson 14: The phrase climb, communicate, confess, comply was not found in any FAA text fetched this session (PHAK Ch 16, AIM 6-2), so that memory aid was skipped per the drafting standard; the lost-procedures aid uses the PHAK's own wording instead.

- Lesson 14: PHAK Ch 16 Lost Procedures text breaks mid-passage at a page boundary in the fetched file, cutting off the end of the direction finding description; only the captured text is used here.
- Lesson 14: Go-around at an unfamiliar airport is a flight task in this lesson, but AFH go-around technique was not part of this session's fetches; technique coverage remains with the Phase 1 lessons.
- Lesson 14: POH fuel burn, speeds, and performance numbers are not reproduced; plan each leg from the airplane's own AFM/POH copy.
- Lesson 14: The em dash inside the 14 CFR 91.151(a) quote and the quotation marks inside the AC 90-66C quote are the sources' own punctuation, retained per verbatim-quote rules; no em or en dashes appear in chapter prose.
- Lesson 15: POH performance numbers, V-speeds, and flap settings are never reproduced; every chart entry and speed comes from the airplane's own POH.
- Lesson 15: The FAA-S-ACS-6C PDF extraction truncated at Area of Operation VII; PA.IX.A (emergency descent) and PA.IX.D (emergency equipment and survival gear) elements were not captured and are not quoted. Area IV tolerances quoted here were captured in full.
- Lesson 15: Phase 1 Module 5's full title was not available to this draft; the section chip uses the pairing wording from the Vol 2 spec.
- Lesson 15: Ground Module 2-2's KSNS and Citabria-specific scenarios were used only as internal grounding; the workbook text keeps fleet-neutral scenario language per the wide-audience rule.
- Lesson 15: Tailwheel-specific soft-field technique lives in AFH 3C Ch 14, which was not fetched this session; tailwheel control positioning defers to the POH and instructor.
- Lesson 15: AFH Ch 18 quotes were same-session verified against the live FAA PDF on 2026-07-07 (Vol 1 verification pass). The chapter PDF now returns no extractable text at both known URLs (re-confirmed 2026-07-31); re-verification awaits a text-bearing copy or a paper-copy check.
- Lesson 16: PHAK Ch 17 (Aeromedical Factors) PDF is 32 MB and the fetch returned no usable text on two attempts (both FAA URL patterns). Night vision physiology in this chapter is grounded in AFH 3C Chapter 11, which covers the same rods, cones, dark adaptation, and blind spot material. Add PHAK Ch 17 citations after a successful fetch if desired.
- Lesson 16: Aircraft-specific night items (electrical system behavior, lighting switches, alternator load management) come only from the POH; POH material not reproduced, read the airplane copy.
- Lesson 16: The 14 CFR quotes flatten eCFR paragraph breaks and omit the em dashes that eCFR prints at paragraph splits; wording inside each quoted span is character for character from the eCFR text fetched 2026-07-31.

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North Aero, Inc. · Curriculum 5.1 · Workbook Volume 2 v1.0 (Phase 2, 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.