SHORT-FIELD TAKEOFF & MAXIMUM PERFORMANCE CLIMB

OVERVIEW

WHAT

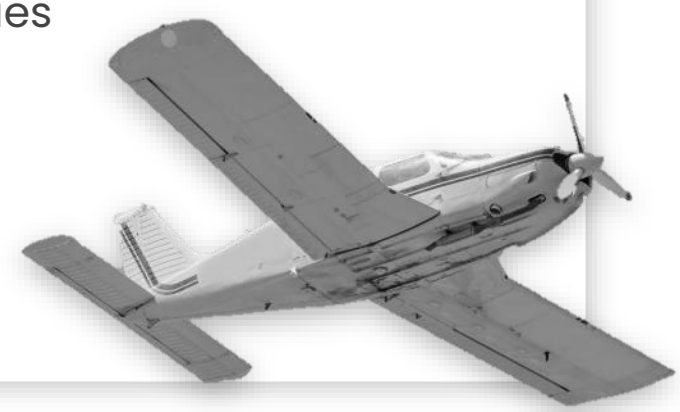
- Takeoffs and climbs from fields where the takeoff area is short, or restricted by obstructions, requiring the pilot to operate at the limit of the airplane's takeoff performance capabilities

WHY

- Develops the ability to operate at the maximum takeoff performance capabilities
- Develops a better feel for the plane and results in improved takeoffs and control
- Provides the ability to use airports that otherwise would not be usable due to performance

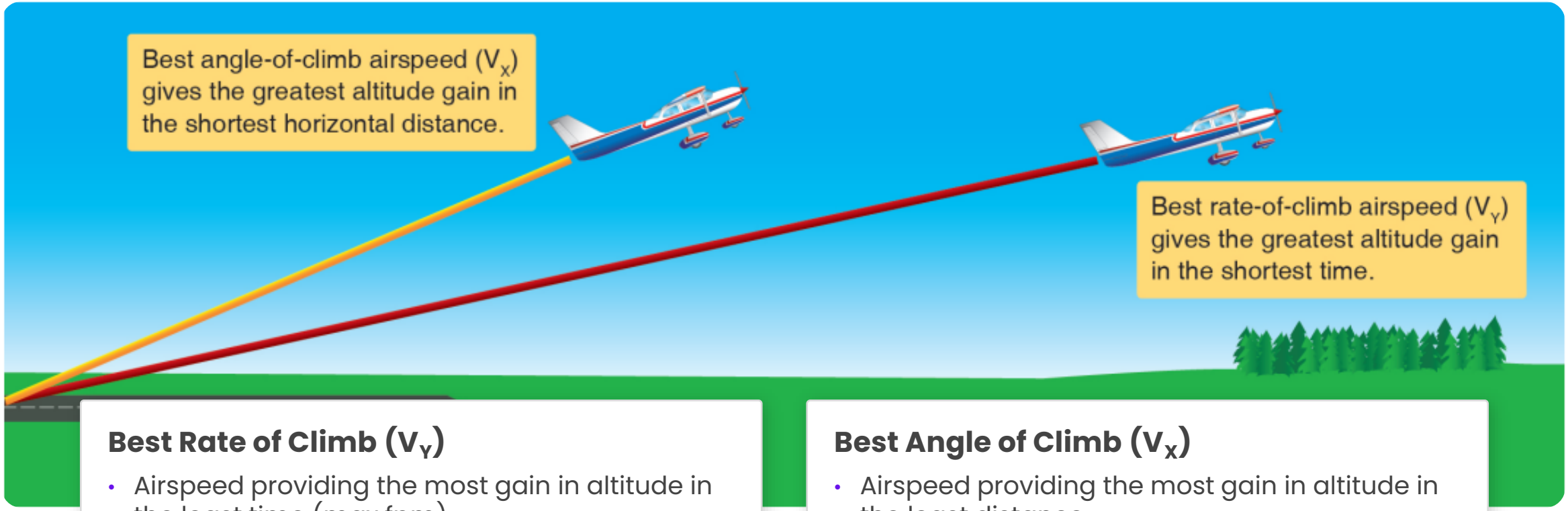
CONTENT

- Best Rate versus Best Angle of Climb
- Pre-Takeoff
- Takeoff Roll
- Lift-Off
- Maximum Performance Climb
- Hazards & Emergencies



SOFT-FIELD OVERVIEW

BEST RATE VS BEST ANGLE OF CLIMB



Best Rate of Climb (V_Y)

- Airspeed providing the most gain in altitude in the least time (max fpm)
- Most excess *power* is available
- Used in normal climb procedures

Best Angle of Climb (V_X)

- Airspeed providing the most gain in altitude in the least distance
- Most excess *thrust* is available
- Used to clear obstacles

RUNWAY SELECTION
LIMITATIONS

Chapter 2 of the POH

Applicable limitations can include:

- Maximum weights
- Center of gravity limitations
- Crosswind & tailwind limitations
- Runway length/width requirements
- Applicable airspeeds

RUNWAY SELECTION
WIND

Reasons for taking off into the wind
- Even when motionless, a headwind provides some airspeed
- Decreases wheel speed necessary for takeoff
- Increases climb performance

Tailwind
- Increases ground roll
- Decreases performance

Crosswind
- Ensure proficiency & within personal minimums

RUNWAY SELECTION
AIRCRAFT PERFORMANCE

Atmospheric Pressure

- Since air is a gas, it can be compressed and expanded
- Changes in air density affect performance

What Changes Air Density?

- Varies directly with pressure
- Varies inversely with temperature
- Varies inversely with altitude
- Varies inversely with humidity

As air becomes less dense, it reduces:

- Power, since the engine takes in less air
- Thrust, since the propeller is less efficient in thin air
- Lift, because thin air exerts less force on the airfoils

RUNWAY SELECTION

RUNWAY CHARACTERISTICS

Surface

- More friction on soft surfaces increases takeoff roll

Gradient

- Upsloping runways increase takeoff roll & vice versa

Condition

- Wet, dry, snow, ice, etc. affect braking effectiveness

Available Distance: Runway length available for takeoff

- Never attempt takeoff on a runway not supported by takeoff data

RUNWAY SELECTION
PERFORMANCE CHARTS

Section 5 of the POH (Performance and Limitations)

Account for atmospheric conditions, runway characteristics, and more

Verify takeoff distance, climb capabilities, etc. are sufficient for the runway & environment

RUNWAY SELECTION
PILOT CAPABILITY

Set and strictly adhere to personal minimums

- Runway length/width, wind, weather, etc.

Ensure proficiency & safety

RUNWAY SELECTION

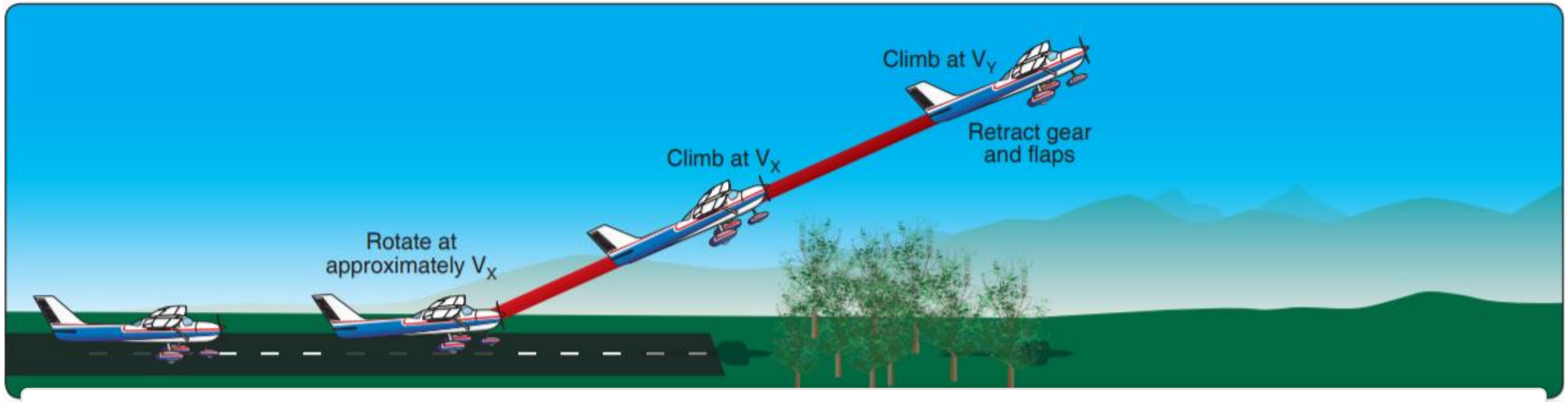
Combination of all the mentioned factors

Generally, boils down to:

Aircraft Limitations + **Aircraft Performance** + **Personal Minimums**

SHORT-FIELD TAKEOFF & CLIMB

CONFIGURATION

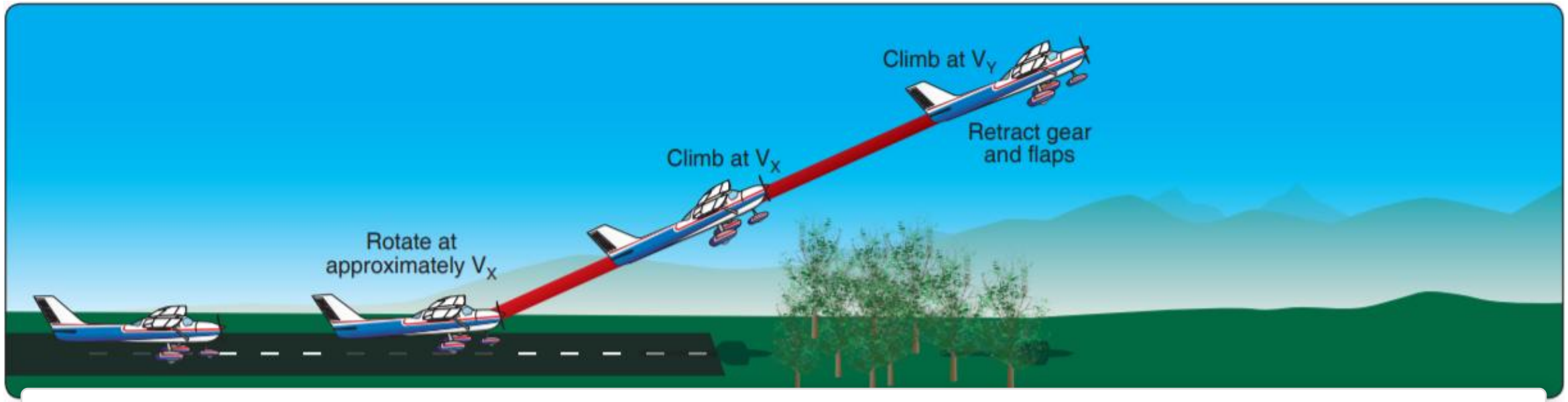


Normal Takeoff Configuration

- Takeoff Flaps
- Unless specified otherwise by the POH

SHORT-FIELD TAKEOFF & CLIMB

TAKEOFF ROLL & LIFTOFF



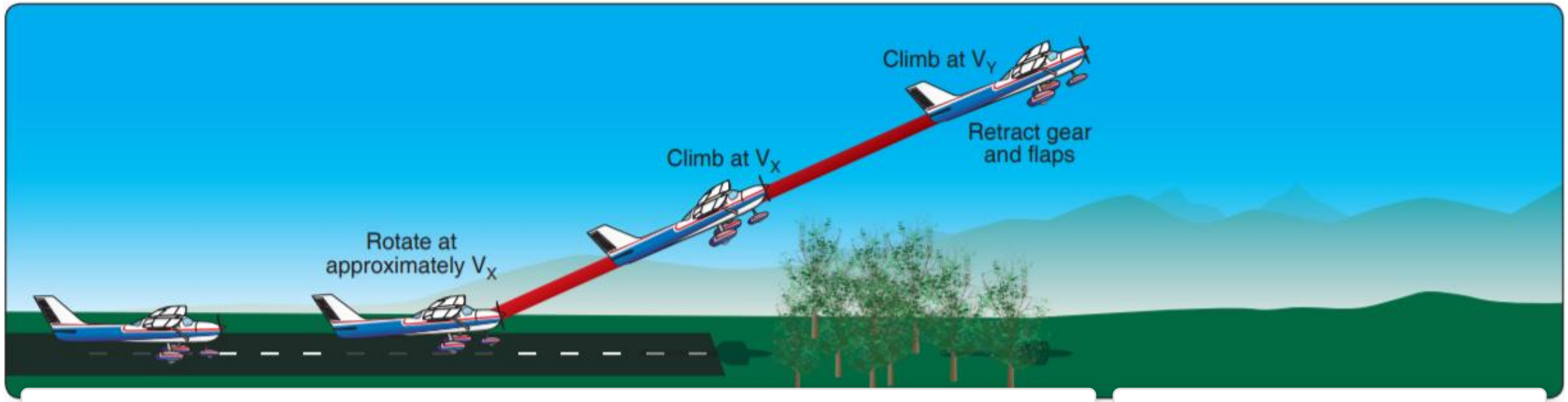
Taxi onto the runway

- Start at the very beginning of the runway (don't waste distance on an already short field)
- Align with the centerline, hold the brakes, & apply crosswind correction

Advance to takeoff power, then release brakes

SHORT-FIELD TAKEOFF & CLIMB

TAKEOFF ROLL & LIFTOFF



Gaining Speed

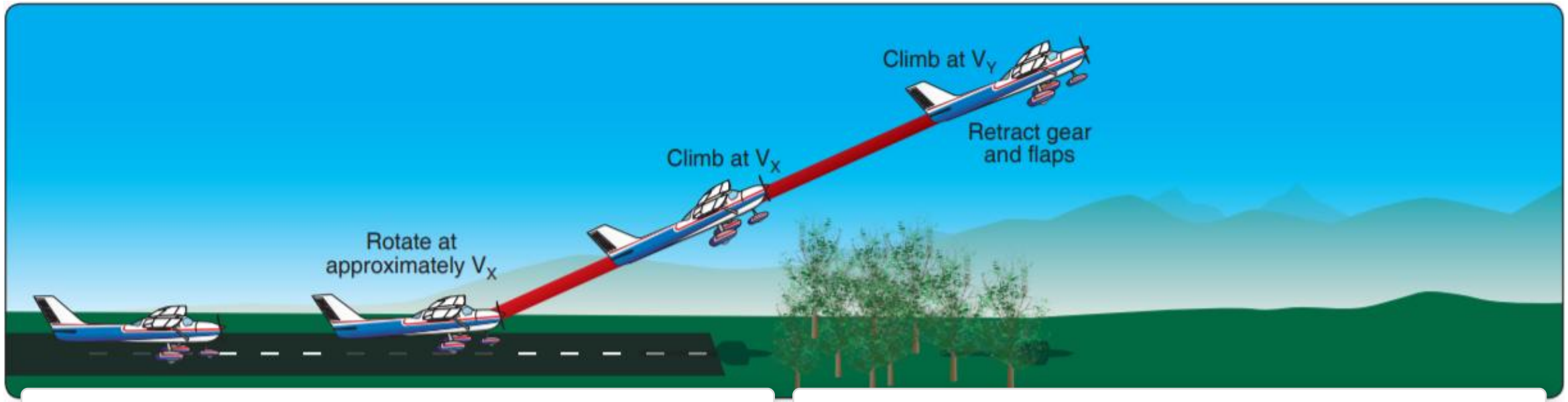
- Check and announce, “gauges green,” and “airspeed alive”
- Use rudder to keep the nose tracking down the centerline
- Keep elevator neutral & full weight on the main wheels for best acceleration

Lift-Off

- Smooth and firm rotation at V_R, pitching to climb at V_X

SHORT-FIELD TAKEOFF & CLIMB

MAX PERFORMANCE CLIMB



Climb at V_X until clear of obstacles

- Maintain visual references, glance at instruments to confirm V_X climb

Maintain configuration until clear of obstacles

Clear of obstacles – Pitch for V_Y

- Transition to a normal takeoff climb site picture
- Once stable, configure per the POH, and complete the climb checklist

COMMON ERRORS
SHORT-FIELD TAKEOFF & CLIMB

- Failure to review POH & performance charts
- Failure to adequately clear the area
- Failure to utilize all available runway/takeoff area
- Failure to have the plane properly trimmed
- Premature lift-off resulting in high drag

COMMON ERRORS
SHORT-FIELD TAKEOFF & CLIMB

- Holding the plane on the ground unnecessarily with excessive forward-elevator pressure
- Inadequate rotation resulting in excessive speed after lift-off
- Inability to attain/maintain V_X
- Fixation on the airspeed indicator during initial climb
- Premature retraction of landing gear or flaps

HAZARDS & EMERGENCIES

HAZARDS
REJECTED TAKEOFF

Emergency conditions can require rejecting the takeoff on the runway

- Examples:
  - Engine malfunctions
  - Inadequate acceleration
  - Runway incursion
  - ATC conflict
- Ensure you can accelerate to V_R and stop on the runway

Prior to takeoff, identify a point at which the airplane should be airborne

- If not airborne, take immediate action

Procedures

- Generally, power idle & maximum breaking while maintaining directional control
- If necessary to shutdown:
  - Mixture idle cutoff
  - Magnetos off
  - Evacuate

HAZARDS
ENGINE FAILURE

Time is of the essence

- Unless prepared, one will likely make the wrong decision or no decision
- Practice, Plan, Brief the Plan

Engine Failure Procedures

- Maintain aircraft control
- During the Takeoff Roll: Reject & stop straight ahead
- Immediately after Takeoff: Land straight ahead
- During the Climb: Lower the nose & release right rudder
  - Establish best glide speed to a landing area
- Time permitting: Notify ATC, Checklists, Attempt a Restart

“We don’t rise to the level of our expectations; we fall to the level of our training”

HAZARDS
WINDSHEAR

Sudden, drastic change in wind speed and/or direction over a short distance

Common Sources

- Frontal activity
- thunderstorms
- temperature inversions
- Surface obstructions
- Strong upper-level winds

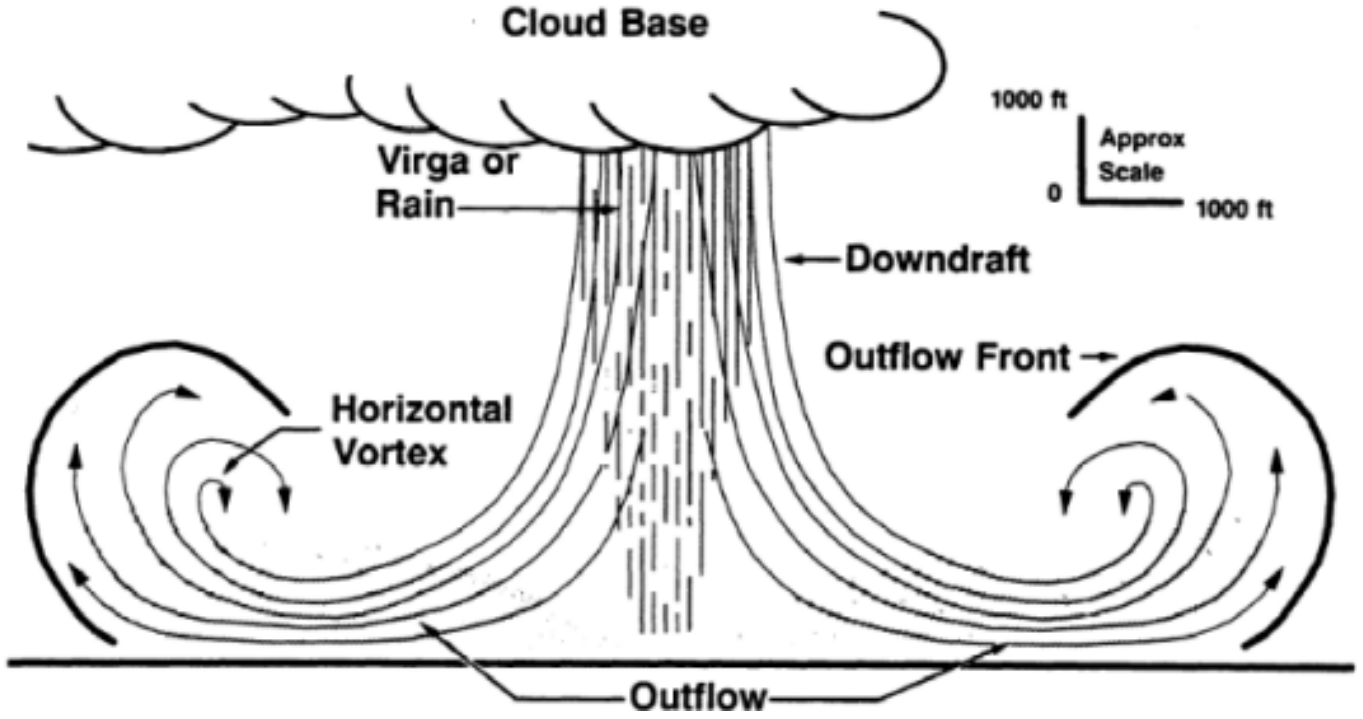
Dangers

- Abrupt changes to horizontal movement
- Violent updrafts and downdrafts
- Rapid changes to performance

HAZARDS
WINDSHEAR

Microbursts

- Most severe type of windshear
- 1–2-mile diameter, 1,000’ depth
- Lasts 5-15 minutes
- Downdrafts up to 6,000 fpm
- Headwind losses of 30-90 knots
- Very strong turbulence and hazardous changes in wind



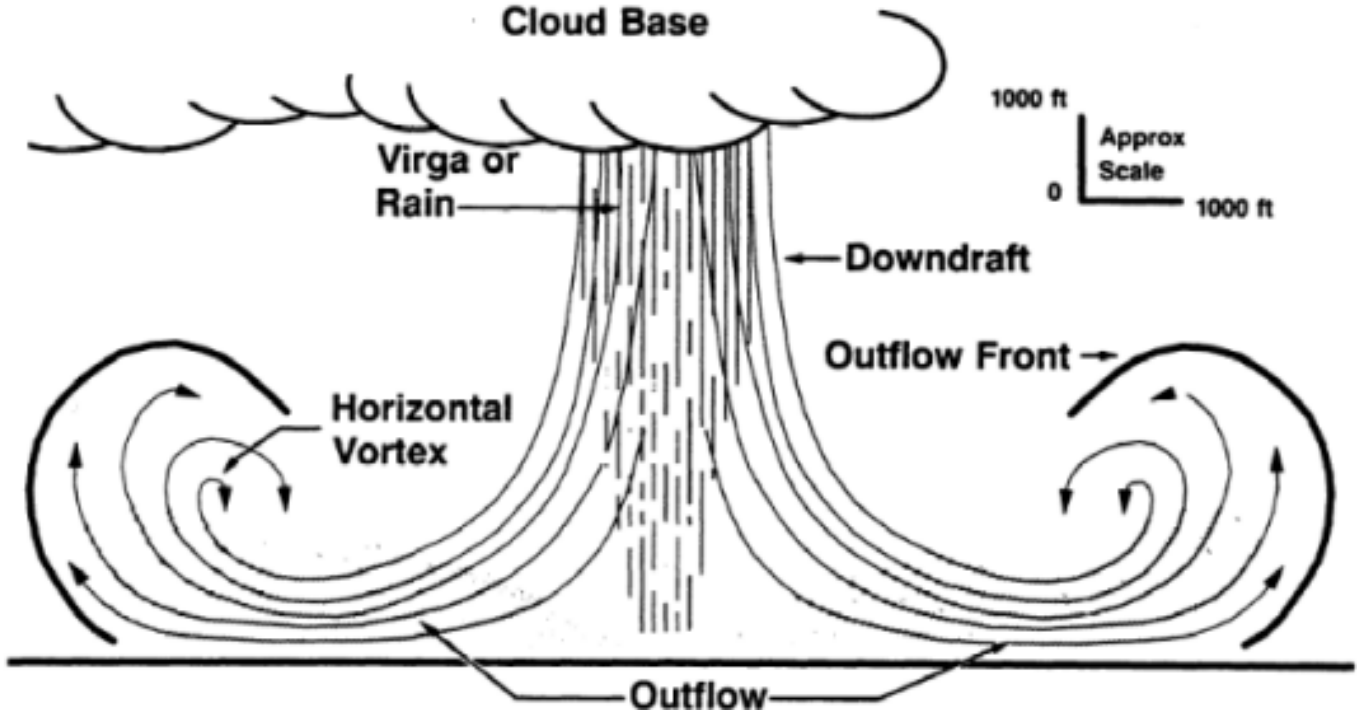
HAZARDS
WINDSHEAR

Visual Indications of a Microburst

- Convective activity (very general)
- Intense rain shaft at the surface, but virga at the cloud base
- Ring of blowing dust

Windshear/Microburst Alerting Systems

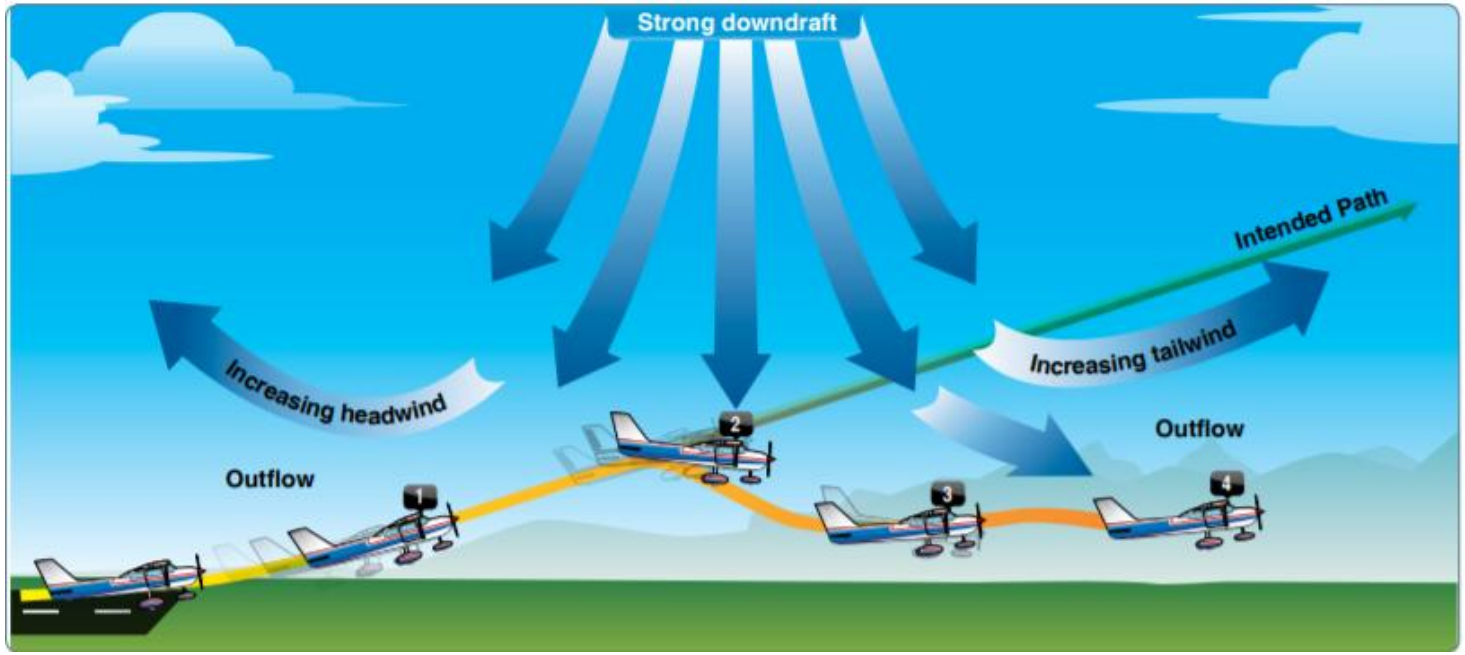
- Major airports use alerting systems
- Many smaller airports have none



HAZARDS
WINDSHEAR

Flying through a Microburst

- Performance increasing headwind
- Performance decreasing downdrafts
- Rapidly increasing tailwind & decreasing performance
- Potential to force the airplane to the ground



HAZARDS
WINDSHEAR

Avoid it, if possible

If unable to avoid, follow manufacturer's procedures

Takeoff/Go-Around Techniques

- Max power, pitch for max climb (do not stall)
- If descending and within 200' AGL, increase pitch attitude as much as possible without stalling
  - Intent is to keep flying as long as possible in hopes of exiting the shear

HAZARDS
WAKE TURBULENCE

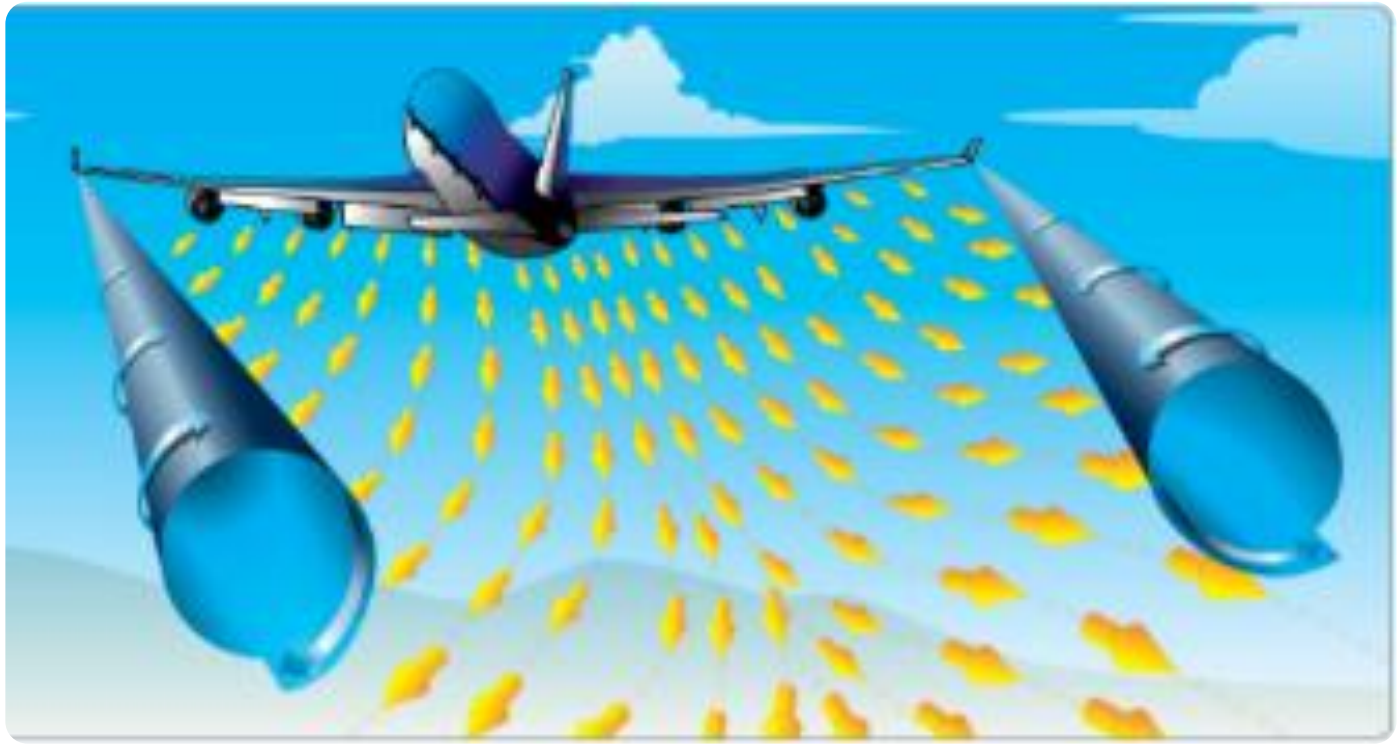
What causes Wake Turbulence?

- Difference between high and low pressure above/below the wing
- Air moves outward, upward, and around the wingtips

All aircraft generate wake turbulence in flight

- The larger the aircraft, the stronger the vortices

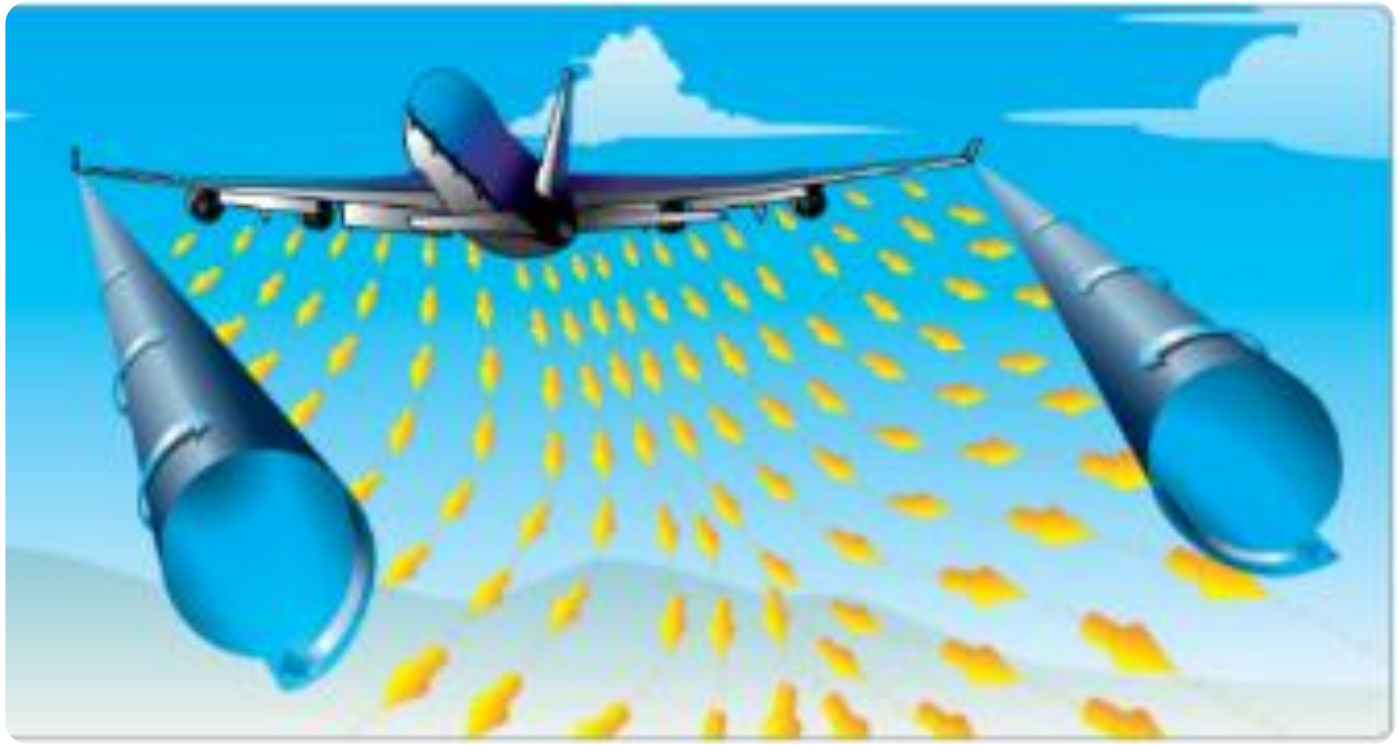
Vortices are strongest when:
Heavy, Clean, & Slow



HAZARDS
WAKE TURBULENCE

Why is it dangerous?

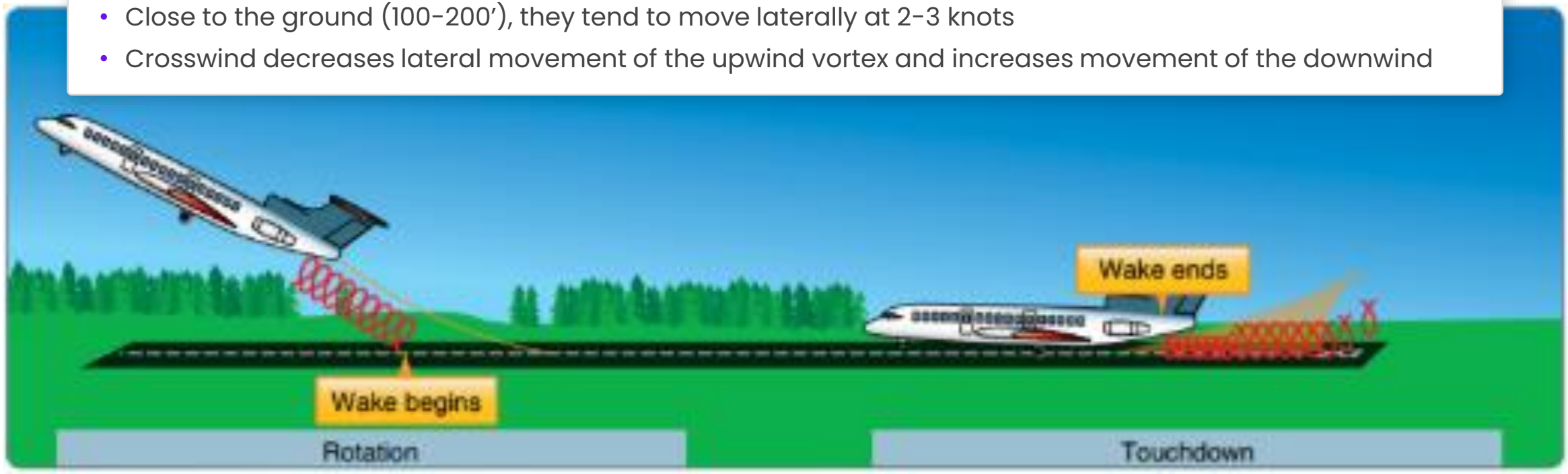
- Rolling moments can exceed control authority and/or cause damage
- Exists in all phases of flight, but are usually strongest at departure



HAZARDS
WAKE TURBULENCE

Vortex Behavior

- Generated from the time an aircraft leaves the ground until it touches down
- Remain about a wingspan apart, drift with the wind, above ground effect altitudes
- Sink at several hundred fpm, slowing descent, and weakening over time
- Close to the ground (100-200'), they tend to move laterally at 2-3 knots
- Crosswind decreases lateral movement of the upwind vortex and increases movement of the downwind



HAZARDS
WAKE TURBULENCE AVOIDANCE

Departing

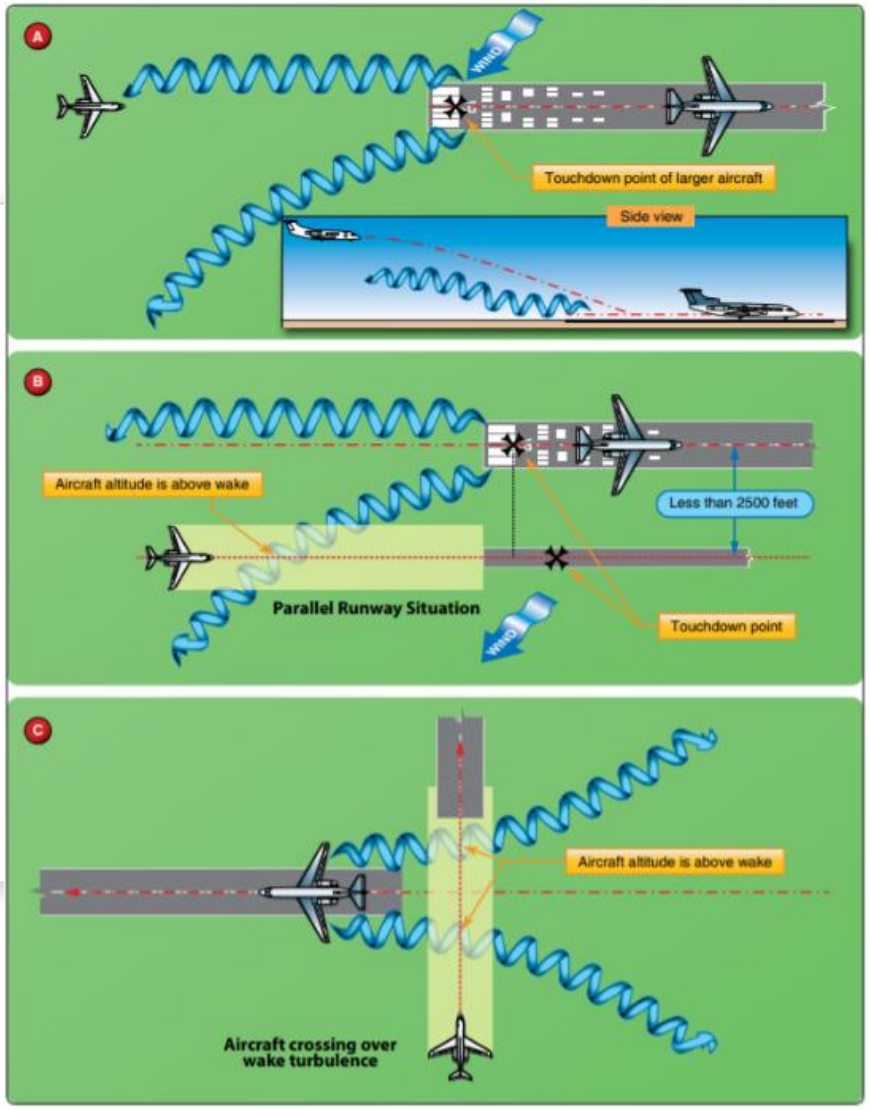
Behind Another Aircraft

- Rotate prior to rotation/climb above their flight path

Intersection Takeoff

- Be alert to larger aircraft operations on runway

Wait 2 mins after a large aircraft flying a missed approach



HAZARDS
DISTRACTIONS

Can be dangerous
- Remove them from view
- If it's a person, explain the situation & ask them to stop

Sterile Cockpit
- Taxi, takeoff, climb, descent, and landing

Aviate, Navigate, Communicate
- Focus on flying

HAZARDS
SA & DISORIENTATION

Extremely important, especially in the pattern

Maintain Situational Awareness & Orientation

- Know where you are, what's coming next, & stay ahead of the airplane
- Be aware of other traffic
- If SA or orientation is lost, admit it, and fix it

Disoriented: Get to a safe attitude, airspeed, and altitude

HAZARDS
TASK PRIORITIZATION

Divide attention between the aircraft, scanning, & communicating

- No responsibility should take full attention for more than a short period

Understand what needs to be accomplished and when

- Use standard operating procedures & checklists

Recognize when you're behind and find a way to catch up

- "Attack the closest alligator"

Safety first!

- Aviate, Navigate, Communicate

HAZARDS
LOW ALTITUDE MANEUVERING

Small problems at high altitude can be big problems at low altitude

Avoid quick, panicked maneuvering

Low Altitude Stall/Spin

- Little to no recovery time
- Maintain coordination and airspeed
- Recover at any indication of a stall and climb to a safe altitude

Spins

- Combination of stall + yaw
- Maintain coordination & airspeeds, use smooth control pressures

HAZARDS
LOW ALTITUDE MANEUVERING

Controlled Flight into Terrain

- Starts on the ground with proper planning and decision making

Recommendations

- Don’t attempt to fly into IMC
- Fly above minimum safe altitudes
- Verify proper altitude
- Verify ATC clearances
- Maintain SA vertically and horizontally
- Comply with appropriate regulations
- Be extra cautious in unfamiliar areas
- Use current charts & reference all available information
- Use appropriate checklists
- Know your aircraft & its equipment

HAZARDS
COLLISION HAZARDS

Collision Avoidance

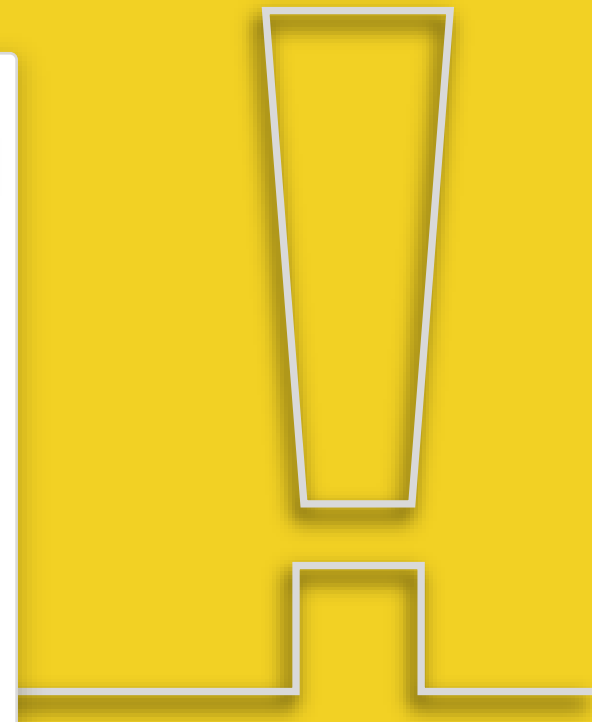
Scanning
- Series of short regularly spaced eye movements

Clearing Procedures
- Before Takeoff: Scan the runway & final approach path
- Climbing: Gentle banks to scan above/below the wings & blind spots

Clearly communicate intentions & location at uncontrolled fields

Operation Lights On
- Turn on landing lights during takeoff & below 10,000’ MSL

Right-of-way rules



HAZARDS
COLLISION HAZARDS

Terrain

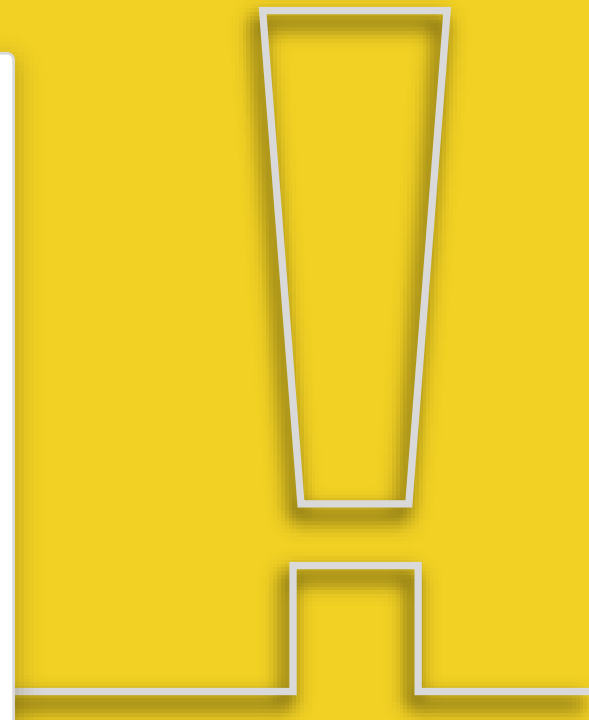
Be aware of hazardous terrain around the airfield

Study the Charts

- Terminal charts & chart supplement
- IFR/VFR chart altitudes
- Use Maximum Elevation Figures and other data

Minimum Safe Altitudes

- Anywhere: Altitude allowing emergency landing without undue hazard
- Congested: 1,000’ above the highest obstacle within 2,000’
- Uncongested: 500’ from the surface
- Water/Sparsely Populated: 500’ from people/property



HAZARDS
COLLISION HAZARDS

Obstacles & Wire Strikes

Be familiar with any obstacles nearby airports

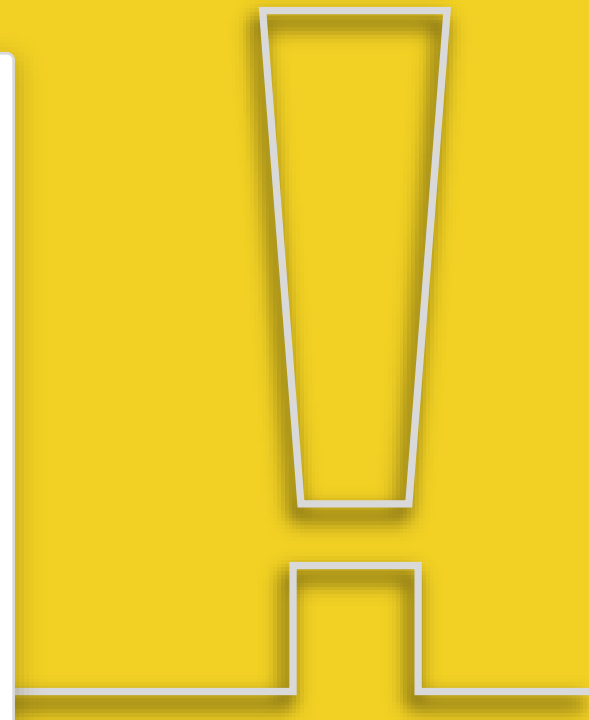
- NOTAMs & Terminal Procedures

Antenna Towers

- Can extend over 1,000’ to 2,000’ AGL
- Supporting guy wires can extend 1,500’ horizontally

Overhead Wires

- Transmission lines often span departures and landmarks pilots follow
  - Lakes, highways, railroad tracks, etc.



HAZARDS
COLLISION HAZARDS

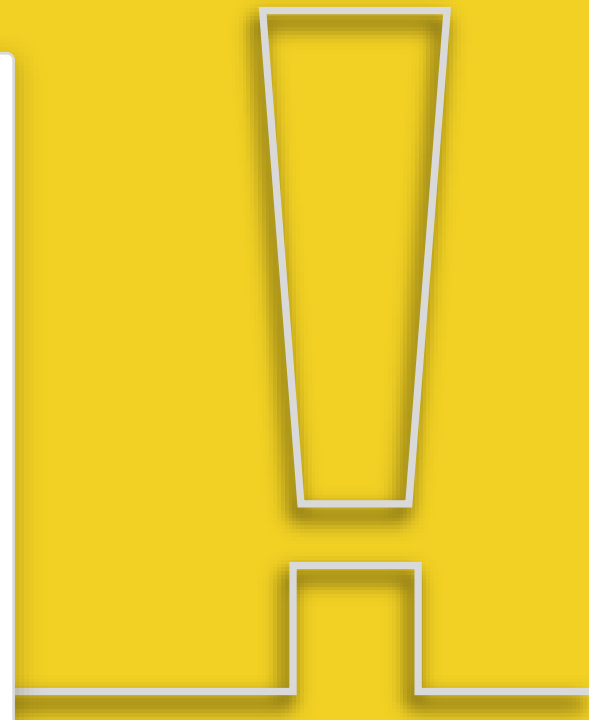
Airport Surface

Scan vigilantly during taxi

- Ensure proper wingtip clearance

Vehicles, Persons, Wildlife, etc.

- Be alert for anyone or anything that may cause a hazard
- Landing: Go around
- Taxiing: Stop until safe to proceed



QUESTIONS?