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GUIDE TO Navigating Aircraft Safely

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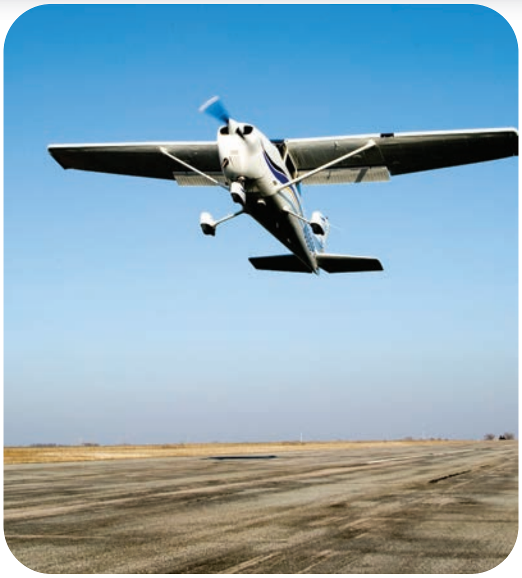


Mastering
Takeoffs & Landings

The “simple” act of taking off or landing accounts for 50 percent of all general aviation accidents.

If there’s one thing that student pilots, flight instructors, and high-time veterans all have in common, it’s a susceptibility to takeoff and landing mishaps.

Why do pilots have so much trouble with these two most fundamental flying skills? It’s simple: Takeoffs and landings require us to operate fast, relatively fragile machines in close proximity to the ground. There’s not much room for error, even under ideal circumstances. Throw in wind, obstructions, and short/soft fields, and things just get worse.

Mastering takeoffs and landings requires attention to detail and a healthy respect for the limitations of airplane and pilot. What’s the field elevation? The temperature? How long is the runway, and what’s the wind speed/direction? Is the airplane heavy? Will you really be able to squeeze “book” performance out of a tired, 30-year-old trainer?

THE 50/50 SOLUTION

The Air Safety Institute (ASI) recommends adding 50 percent to the POH takeoff or landing distance for obstacle clearance. For example: If the book specifies a minimum of 600 meters, add 300 meters (50 percent) for a safety distance of 900 meters.

The two checklists in this article are full of tips for mitigating the numerous risks associated with takeoffs and landings. As you read them, remember that the root cause of most accidents is poor judgment. Know the aircraft, the airport, and the environment… but most importantly, know when it’s time for you to divert, go around, or stay on the ground.

TAKEOFF & CLIMB

The "Impossible Turn": If the engine fails shortly after takeoff, should you try to turn around and land on the departure runway? The viability of the so-called "impossible turn" depends on the circumstances, but there are plenty of reasons to be wary. The maneuver requires substantial altitude and involves relatively aggressive maneuvering. Taken by surprise, pilots often fail to maintain airspeed and end up having stall/spin accidents. Unless you're close to pattern altitude, or have already started a turn when the engine fails, it's safer to land straight ahead—i.e., within the area you can see out the windshield.

FLIGHT ENVIRONMENT	RISK FACTOR	RISK MANAGEMENT
☑ **Runway Length**	"Short" runway.	· 50/50 solution (see pg. 2). · Use all available runway.
☑ **Density Altitude**	High density altitude.	· Fly in cooler temperatures. · Decrease fuel and/or cargo. · Use longer runways. · Avoid runways with obstacles.
☑ **Obstructions**	Increased climb angle. Obstructions may cause turbulence.	· Maintain **Vx** until clear of obstacles. · Then maintain **Vy**.
☑ **Wind**	Loss of control. Tailwind will increase runway length needed.	· Deflect ailerons into the wind. · Too much wind? Use another runway. · Use a higher rotation speed. · Avoid tailwinds unless you have no other option (example: one-way runway).
☑ **Runway Slope**	Taking off uphill.	· Usually best to takeoff downhill. · Risks vary with wind, runway slope, terrain. · Generally requires more runway. · Acceleration will be slower. · May be difficult to outclimb terrain. · Talk to local pilots or airport manager.
☑ **Soft or Contaminated**	Soft. Slush or snow.	· Perform a soft-field takeoff. · Keep weight off the nosewheel. · Transition from taxi to takeoff without stopping. · Once airborne, accelerate in ground effect before climb out.
☑ **Heavy Aircraft**	Increased takeoff roll and reduced climb.	· Use a longer runway, especially with high density altitude.
☑ **Night**	Decreased visibility. Disorientation.	· Stay night proficient. · Avoid short runways at night.

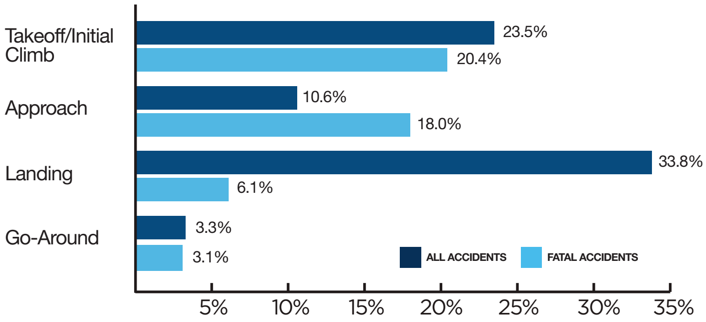
APPROACH & LANDING

Going Around: If you have a problem during approach or landing, there's almost always a simple solution: Go around! It's far better to make another trip around the pattern than to push ahead and risk a runway overshoot or loss of control. Unfortunately, a lot of pilots seem to forget that it's an option, and end up having accidents they could easily have avoided. That said, there are some risks involved with go-arounds. Especially at low altitudes and airspeeds, with flaps down, going around can be a "touchy" maneuver: If you don't feel comfortable, get some practice with a flight instructor.

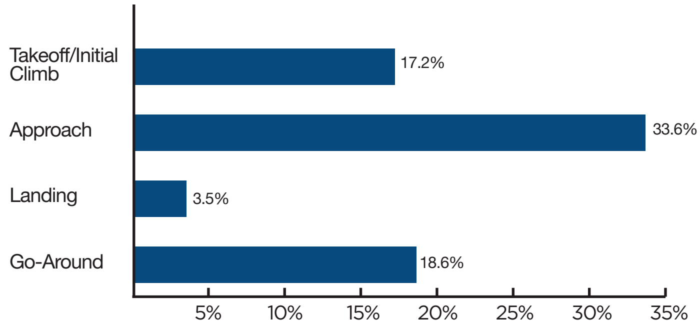
FLIGHT ENVIRONMENT	RISK FACTOR	RISK MANAGEMENT
☑ **Runway Length**	"Short" runway.	· 50/50 solution (see pg. 2). · Configure the aircraft for a short-field landing. · Use aggressive braking.
☑ **Density Altitude**	High density altitude.	· Decreases performance during a go-around. · Increases landing distance.
☑ **Obstructions**	Short runway.	· 50/50 solution (see pg. 2). · Maintain target speed. · Use short-field configuration.
☑ **Wind**	Loss of control.	· Deflect ailerons into the wind. · Crab or slip on approach. · Too much wind? Use another runway.
	Gusty conditions.	· Add 1/2 the gust factor to your approach airspeed.
	Tailwind.	· Avoid tailwinds unless you have no other option (example: one-way runway). · Under some conditions, airport may be unusable.
☑ **Runway Slope**	Landing downhill.	· Usually best to land uphill. · Risks vary with wind and runway slope. · Generally requires more runway. · Under some conditions, airports may be unusable. · Talk to local pilots or airport manager.
☑ **Soft or Contaminated**	Soft. Slush or snow.	· Keep weight off the nosewheel. · Keep moving until clear of the runway.
☑ **Heavy Aircraft**	Increased landing distance.	· Use a longer runway, especially with high density altitude.
☑ **Night**	Decreased visibility. Disorientation. Optical illusions.	· Stay night proficient. · Avoid short runways at night. · Use runways equipped with visual or electronic glideslope indicators.

U.S. TAKEOFF & LANDING ACCIDENTS
2000-2009

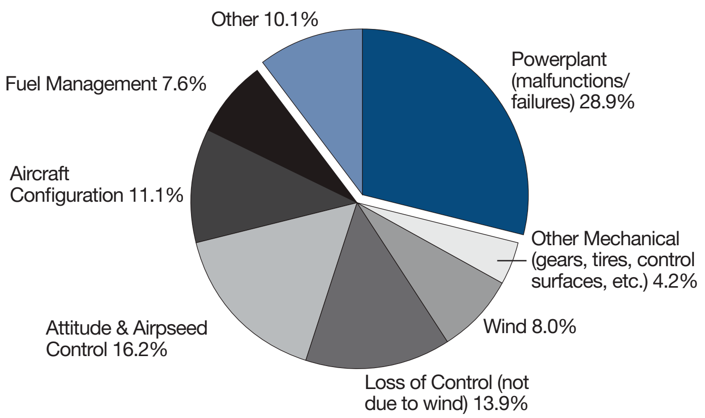
ACCIDENTS BY CATEGORY



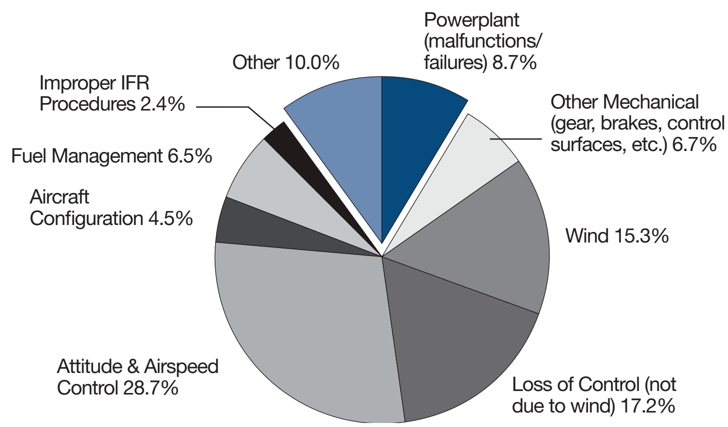
LETHALITY INDEX



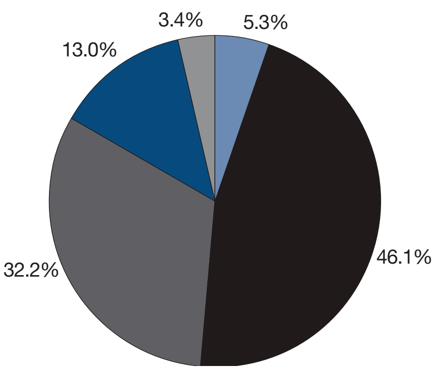
TAKEOFF & INITIAL CLIMB ACCIDENT CAUSES



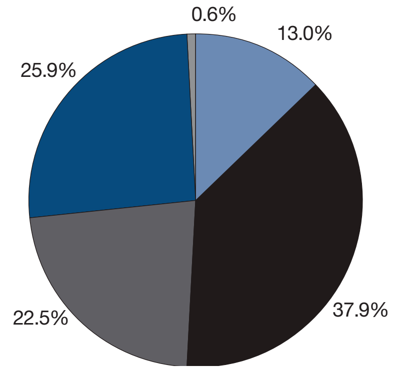
APPROACH, LANDING, & GO-AROUND ACCIDENT CAUSES



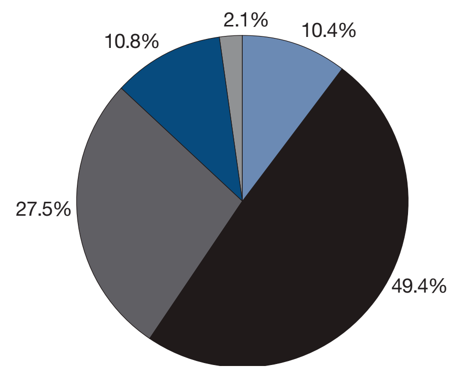
TAKEOFF & INITIAL CLIMB
PIC'S HIGHEST CERTIFICATE LEVEL



DISTRIBUTION OF CERTIFICATE LEVELS
ALL ACTIVE PILOTS (2009)



APPROACH, LANDING & GO-AROUND
PIC'S HIGHEST CERTIFICATE LEVEL



STUDENT PRIVATE COMMERCIAL ATP OTHER

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WeatherWise

Practical Tips and Tactical Tricks

The moment a person says, "I'm going to learn to fly," that person needs to add, "and I'll learn weather, too." Flying and weather should be thought of as one skill, one art, never separated.

—Captain Robert N. Buck, "Weather Flying"

Weather is the most critical and complex variable that affects your flying. But you don't have to be a meteorologist to understand what makes weather, or to use that understanding to help make sound flight decisions. This is what being weather wise is all about—the ability to integrate official reports and forecasts with what you can see outside to cope with changing flight conditions in the real world. Wouldn't you like to be *WeatherWise*?

FRONTS

Fearsome weather often occurs when different air masses—that is, large areas of air with similar properties of temperature, pressure, humidity, and stability—collide. The collision line is called a front. The four basic types of fronts are:

COLD FRONT

Cooler air is pushing warmer air out of the way. If you're looking for violent weather, you're more likely to find it along a cold front than a warm front.

WARM FRONT

Warmer air is slowly displacing cooler air. Though less severe than a cold front, warm fronts frequently cause low ceilings and visibilities.

STATIONARY FRONT

Occurs where two air masses meet, but neither is displacing the other. These fronts can exhibit characteristics of a warm front, cold front, or both.

OCCLUDED FRONT

Occurs when a cold air mass overtakes a warm air mass, so that the leading edge of both occupies the same location. Occluded fronts occasionally have severe weather.

PRACTICAL TIPS

- Seeing the windsock change direction is one of the most obvious signs of frontal passage. To determine frontal passage in the air, watch for a change in your wind correction angle and look for changes in the outside air temperature (OAT). Also, note any differences in altimeter settings reported by air traffic control or on meteorologic reports.
- Note any nearby fronts, even if they're not expected to be a factor for your flight. This will give you a better big picture when (not if) the forecast proves wrong.
- For longer cross-countries, a rule of thumb is that weather typically changes every 700 kilometers. But it can also change much more quickly.
- If a front is forecast to pass your destination, call the airport before departing to see if passage has already occurred.
- To check on a front's progress, look at stations on either side of the front and compare actual conditions to the forecast weather.

STABILITY

Is the air around you stable or unstable? The more stable an air mass, the less likely you'll see violent weather. Cloud types reflect the degree of stability.

STRATUS CLOUDS—A SIGN OF STABLE AIR

PRACTICAL TIPS

What do stable and unstable air masses look like?

- Stable air has smooth air, sometimes poor visibility, and steady precipitation. Clouds form in horizontal layers.
- Unstable air has turbulence, usually (but not always) good visibility, and often thunderstorms and intense precipitation. Clouds develop vertically. The higher the vertical development, the more unstable the air.

PRECIPITATION AND VISIBILITY

When it comes to accident statistics, **low ceilings and visibilities rank as *the* greatest weather hazard** to pilots who are not qualified to fly by instruments. Not thunder, ice, high winds, or turbulence: Nothing seems less threatening, or is more dangerous, than simple, condensed water vapor. Learn to respect it!

Precipitation occurs in both liquid (rain) and solid (snow, hail) forms. Precipitation type and intensity affect visibility. Light precipitation may not prevent flight by visual references, but moderate precipitation can reduce visibility below the required minimum. Heavy precipitation most likely means that instrument conditions will prevail.

Visibility is a critical part of flight safety. Water in the atmosphere might appear as precipitation or fog, or hold suspended particles that cause haze. The amount of water the air can hold rises with the temperature. As the temperature goes down (such as in the evening), it may reach the temperature at which the air mass just can't hold any more water. That's called the dew point. The difference between the temperature and the dew point is called the *temperature-dew point spread*. When the temperature and dew point meet at altitude, water appears as rain, clouds, or snow. When they meet near the ground, water condenses into fog.

PRACTICAL TIPS

- The temperature-dew point spread decreases as the temperature drops, usually in the very early morning and at night. Fog is most likely to occur at these times, and can form quickly after sundown or at sunrise.
- At night, fog obscures lights and gives them a hazy or fuzzy cast. Look down occasionally as you fly at night, since fuzzy lights are likely the first indication that fog is forming below you.
- When precipitation is in the forecast, visibility may deteriorate.
- Fog "burns off" in the morning because the rising sun heats the air, pushing the air mass's temperature above its dew point, vaporizing the water. If there is a higher overcast layer on a foggy morning, however, it can block the sun and inhibit the burn-off.
- Flying in very hazy conditions is tough enough, but it gets even more challenging when flying into the sun. In such conditions, 5 or even 10 kilometers visibility might not be enough.
- In hazy air, visibility appears to drop dramatically just after sunset, but will generally improve just as quickly when total darkness arrives.

THUNDERSTORMS

Thunderstorms can be categorized by their origin, and each has its associated characteristics, but you can think of them as *bad, worse, and impossible!*

THUNDERSTORM

FRONTAL THUNDERSTORM

Caused by a cold front pushing into a warmer air mass with lots of moisture; difficult, if not impossible to circumnavigate.

AIR MASS THUNDERSTORM

Occurs on summer afternoons as a result of daytime heating. Usually isolated; you *may* be able to maneuver around them.

EMBEDDED THUNDERSTORM

Thunderstorms hidden in solid masses of other clouds. These storms can sometimes be avoided by getting on top of the cloud layer and watching for buildups, or by staying low (if ceilings and visibilities permit) and navigating around rain shafts. Instrument pilots plowing through the clouds without thunderstorm detection equipment are at greater risk from embedded thunderstorms.

PRACTICAL TIPS

- Stay at least 32 kilometers away from a thunderstorm. Wind shear, gust fronts, turbulence, and hail can all occur within this distance.
- A storm moves in the direction of its anvil. To approximate the speed and direction of the storm, use winds aloft at FL 120.
- It's usually better to circumnavigate on the backside of a thunderstorm away from the anvil. However, the southwest corner is often where tornadoes form.
- Use caution under the anvil between cloud layers. This area sometimes contains hail.
- Select an altitude that will let you see the cloud buildups. Recognize that it may be higher than most light aircraft can fly and may require oxygen for the pilot.
- Ask for assistance from air traffic control in avoiding convective activity you can't visually identify, but remember that weather separation is a secondary duty for controllers. As pilot in command, the ultimate safety of the flight rests with you. There is an art to flying around thunderstorms that can't be developed just by reading or taking courses. It must be learned by experience—very carefully.
- If caught in a thunderstorm, focus on keeping the airplane right side up. If possible, avoid making turns. Adjust to your aircraft's maneuvering speed (V_A). Lowering the landing gear may also help stabilize the airplane. Do NOT lower the flaps.

TURBULENCE

At altitude, turbulence can range from uncomfortable to catastrophic. Close to the ground, it can turn a routine landing into an accident. Turbulence is classified by intensity and type:

KELVIN-HELMHOLTZ WAVES—A SIGN OF TURBULENT AIR

INTENSITY

Light turbulence can momentarily cause slight, erratic changes in altitude and/or attitude. Many GA pilots will report vigorous light turbulence as moderate. Aircraft type (wing loading) may greatly influence the perception of severity.

Moderate turbulence can cause changes in attitude and/or altitude, and usually, variations in indicated airspeed as well. The aircraft remains under control, but the ride will be uncomfortable.

Severe turbulence induces large, abrupt changes in attitude and/or altitude, as well as airspeed. *The aircraft may momentarily be out of control.*

Extreme turbulence, in addition to all of the above, renders the aircraft nearly impossible to control, and may cause structural damage.

TYPE

The three most common types of turbulence are convective, mechanical, and wind shear.

Convective turbulence results from lifting action. This is the turbulence associated with thunderstorms.

Topography can cause **mechanical** turbulence. Airports known for having “squirrelly” winds, for example, typically earn their reputation due to topographical factors. Strong winds near mountains often create moderate or severe turbulence.

Wind shear occurs at the point of a change in wind direction and/or speed. Wind shear is often associated with thunderstorms or microbursts, but strong winds aloft and light winds at the surface may also cause wind shear.

Clouds are excellent “signposts” for rough air. Standing lenticular clouds and rotor clouds signify the presence of turbulence and should be given a wide berth. Similarly, any clouds that resemble crashing waves or appear as if they’ve been shredded indicate turbulence. Towering cumulus or cumulonimbus can also generate severe or extreme turbulence.

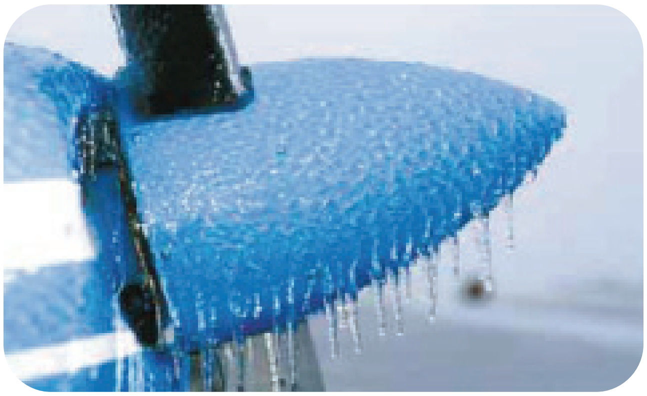
PRACTICAL TIPS

- Ask local pilots about topography or other airport conditions that may create mechanical turbulence.
- Summertime bumps almost always end at the top of the haze layer. Climb above the haze, and your passengers will thank you.
- Climb above a deck of puffy cumulus, and your ride will generally smooth out. In the summer, the tops may quickly climb as high as FL 120, and climbing above may not be practical. Tops during winter tend to be lower.
- Fly early or late. The air is most turbulent between the hours of 10 a.m. and 5 p.m., when the heating of the ground sets updrafts in motion.

- If you encounter turbulence, slow to maneuvering speed (V_A). Maintain attitude, but don't fight to hold altitude.
- Tighten seat belts; use the belts on unoccupied seats to secure any loose items. It's much easier to secure the cabin *before* takeoff. Incorporate this task into your preflight checklist.
- If flying in a complex airplane, lower the gear to help stabilize the aircraft.
- Advise passengers when turbulence is expected, so that they are prepared for the encounter. Assign them tasks that will keep them focused outside the aircraft, such as looking for checkpoints or other landmarks.

ICING

Structural and carburetor ice are both serious. Structural ice on your airplane can make it incapable of flight. It can only form on your airplane when the temperature is zero degrees centigrade or below in visible moisture—that is, in a cloud, or perhaps in freezing rain. Carburetor ice can occur on warm, sunny days and cause engine failure. Thankfully, all airplanes susceptible to carburetor ice have a carburetor heat system. For more information on handling icing conditions, please read the AOPA Air Safety Foundation's Safety Advisor *Aircraft Icing* (http://www.aopa.org/asf/publications/sa11.pdf).



PRACTICAL TIPS

- Take the freezing level and cloud bases into account if planning an instrument flight, and choose an altitude that will keep you out of either freezing cold air or clouds, unless your aircraft is approved for flight in icing conditions.
- Watch the OAT gauge as you climb to cruising altitude and note the freezing level. This way, you'll know how far to descend to find warm air if ice begins to form.
- If you encounter ice when flying above the minimum altitude required on an instrument flight, remember that you may be able to descend and still be clear of obstructions. Know the required minimum altitudes, and be ready to descend to, but not below, them unless it's an emergency.
- Icing is subject to regional and seasonal influences. Be familiar with the icing factors that dominate the skies in which you fly.
- Check airmets and sigmets for areas of potential icing.
- Look for the freezing level in the winds aloft chart and area forecast.
- The absence of pilot reports (pireps) of icing may merely indicate that no one in the area is flying.
- Seeing rainbows in the cloud tops when flying above a cloud deck usually indicates icing conditions.
- Icing is most severe near the top of the cloud. When descending into clouds in below-freezing temperatures, expedite your descent to minimize any icing encounter.

- Monitor the EGT in potential carburetor icing conditions. The EGT will fluctuate when carburetor ice is initially forming, giving an earlier warning than the traditional symptom of lower manifold pressure or decreasing RPM.
- Help other pilots by reporting any icing to air traffic control.

FORECAST VS. REALITY

Forecasts are educated guesses, not guarantees. As in any endeavor, practice improves performance: Pay attention to the weather even when you're not flying. Note what kind of weather system predominates, how it looks, and what it does. When flying, compare the forecast with actual conditions you encounter. Pay attention to trends. **And always leave yourself an out.** That's what being *WeatherWise* is all about.

THIS GUIDE IS JUST ONE EXAMPLE OF THE MANY RESOURCES AOPA AND THE AIR SAFETY INSTITUTE PROVIDE.

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