

# #1 SAFETY PUBLICATIONS/ARTICLES

## BREAKING THE ACCIDENT CHAIN

In our training, we have all heard of the infamous accident chain and the connecting links that ultimately lead to an aircraft accident. If at any point leading up to the accident a link is broken by a sound decision, the accident is prevented. Recently I have been analyzing a number of aircraft accident cases from the NTSB database. The links of an accident chain stand out dramatically in every case I examined. When teaching students aeronautical decision making, flight instructors should emphasize the importance of the accident chain in preventing accidents.

Consider this recent case. A student pilot with 1.7 hours of dual night experience flew a Cessna 150, solo, 48 nm from his home base to another airport so that he could meet an instructor and fulfill his night cross-country requirement. It was still daylight when he landed. The instructor found him totally unprepared and tired, but anxious to get the night cross-country out of the way. The instructor spent a considerable amount of time with him to prepare for the flight but was hurried because it was getting late. The instructor calculated from the pilot's operating handbook that, considering the flight time from the home base and the three legs involved in the cross-country, there would be enough fuel with a 45-minute reserve to complete the mission. He elected not to refuel.

After dark the flight began. Shortly before reaching the first airport, the generator warning light illuminated. The student told the instructor, "it happens all the time. It's a bad light." There was no ammeter installed in the airplane to confirm the faulty indication. They did a touch and go at this airport and proceeded on the second leg. During the approach to the next airport, the instructor had a problem activating the pilot-controlled lighting with the radio, but he dismissed it as not being close enough to the airport. After finally getting the runway lights on they executed a touch and go and began the third leg back to the airport where the cross-country flight originated. The generator light remained illuminated.

During the last leg of the flight the instructor noted that the gas gauges were showing almost empty. It is at that point the student told the instructor that the Continental O-200 in this airplane burned more fuel per hour than indicated in the POH. Neither realized that the fuel gauges on this airplane were electrically driven and that a power failure will cause the gauges to show empty. Needless to say, this added a lot more stress and anxiety to the flight.

Upon arriving at the airport at 10:40 p.m., the instructor was unable to activate the runway lights with the radio. By now the cockpit lights, landing light, radio, and flaps had all failed because of the generator problem. The instructor located the rotating beacon on the field and had identified the runway orientation. On short final, the student turned on a flashlight to examine one of the instruments, momentarily blinding the instructor. The airplane bounced several times along the side of the runway and ended up in a ditch, killing the student and seriously injuring the instructor. This 1965-model airplane did not have shoulder harnesses.

In hindsight, this instructional flight was a disaster from the beginning. Let's look at the links in the accident chain:

1. The student flew 48 nm from his home to the lesson and was tired and unprepared. Break the link by sending him home to fly his cross-country another day. (It is not known from the accident report whether the student pilot had the proper training and endorsements for repeated solo flights to airports fewer than 50 nm from the base airport.)
2. The instructor was not familiar with the aircraft's quirks, such as ongoing generator problems and abnormal fuel burn. Break the link by having full knowledge of the airplane and not flying until the airplane is adequately repaired. The lack of an ammeter while flying at night should cause concern.
3. The generator warning light was ignored. Break the link by landing after the first leg and checking it out.

4. The instructor had trouble getting the runway lights to activate at the second airport. Break the link by realizing that too many things are now beginning to go wrong. It's time to get on the ground.
5. The student and instructor thought the airplane was running out of fuel because they did not realize that the gas gauges are electrical. This added to the stress of getting the airplane on the ground as soon as possible at the end of the final leg. Break the link by knowing how airplane systems work.
6. The student was not aware that turning on a flashlight would destroy night vision. Break the link by ensuring students understand all aspects of night flying, including the characteristics of night vision, during their night proficiency briefing.

There were six links in this accident chain. Breaking any one of them before or during the flight would likely have prevented the accident. The lesson here is to teach your students to recognize when the links are beginning to develop and do something about them. It's a time-tested method to prevent tragic accidents like the one we discussed.

# #2 FULL HOUSE: KNOW YOUR AIRCRAFT PERFORMANCE LIMITS

By David Jack Kenny

Flight instruction is necessarily incomplete. The training curriculum and practical test standards are intended to assure that a new pilot knows how to address situations likely to arise after the checkride, but there's no way to demonstrate every single one during training. Among students who learn to fly in four-seat or larger aircraft, one of those most widely overlooked is flying with all the seats filled. It's common to pass the private pilot checkride without ever having experienced how the aircraft handles near its maximum gross weight—and few instructors will risk taking off significantly above it.

About 8:20 p.m. on Aug. 25, 2014, a 20-year-old private pilot reserved a Cessna 172R operated by a flying club based at the [Cuyahoga County Airport](#) just outside Cleveland. He'd joined the club 10 months earlier but only flown its airplanes four times, twice that previous October and two more times in June. His membership application listed 104.3 hours of total flight experience.

He arrived with three passengers around 9 p.m. All four were students at Case Western Reserve University. One passenger and the pilot were fraternity brothers; the other two, both freshmen, were prospective members. All three passengers were members of the Case Western wrestling team. Workers at the adjacent corporate hangar saw the four board the aircraft and start it up, and reported that they spent an unusually long time—perhaps 20 or 30 minutes—running up the engine.

At 9:46 p.m., the pilot contacted ground control and was cleared to taxi to Runway 6. After one wrong turn, he reached the threshold and advised the tower controller that he was ready to take off “to the east ... we're just doing some

sightseeing and then we'll be back here in a little bit." The Skyhawk was cleared to take off on Runway 6 with a right turn out.

Three witnesses at the FBO at the north end of the field saw it lift off about 2,000 feet down the runway, only to struggle to climb. One minute and 20 seconds after starting the takeoff roll, the pilot radioed that "we're not climbing fast ... We're gonna make a left turn if that's possible, immediately, to turn around." The tower controller approved the left turn, then watched the Cessna roll hard to the left and crash just beyond the airport fence. Fire consumed most of the aircraft before first responders reached the scene. No one on board survived.

The NTSB's accident investigators found that the airplane was configured correctly, with the fuel selector set to "Both," mixture full rich, and flaps retracted. The engine appeared to have been making normal power up to the moment of impact. Pathology results were negative for all potentially impairing drugs, including alcohol. The airplane's center of gravity was within limits, but depending on the exact weights of the passengers, the Cessna was at least 95 pounds and perhaps as much as 165 pounds above its authorized maximum gross weight. Witnesses at the fraternity house recalled that when he'd offered the ride, the pilot had asked his prospective passengers for their weights, "did the math in his head to see if they would be below the weight limit, and he believed they would be."

One of general aviation's unsavory secrets is that pilots do sometimes attempt overweight takeoffs. Once you exceed the maximum gross weight established by the manufacturer, though, there's no way beyond trial and error to know how much is too much. At some point, an airplane simply can't climb out of ground effect. A little lighter, and it will climb—but just barely, and on the verge of a stall.

A highly experienced pilot, feeling how close to stalling the airplane is with wings level, might realize that it couldn't maintain altitude in a turn. The only options left would be to land straight ahead—not inviting at night—or coax the craft up to a thousand feet or so in a straight-ahead climb. With some altitude, descending

through the turns would make it possible to conserve airspeed and keep the angle of attack below its critical value. It would still be a delicate business, even in daylight. After the accident, the young man's instructor advised the FAA inspector assisting with the investigation that "though he was not very experienced ... he was always very cautious, never took chances, and never was even a hint of reckless or foolhardy." The NTSB was correct to note that he should have calculated the aircraft weight more precisely. Once that mistake was made, though, his lack of exposure to that corner of the flight envelope left him little chance of figuring out how to cope with a bewilderingly unfamiliar situation.

# #3 NEXRAD WAETHER IMAGES ARE LATER THAN YOU THINK

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By David Jack Kenny

From time to time, the National Transportation Safety Board issues safety alerts in response to hazards its members feel merit more attention. It's fair to say that the aviation community has been more receptive to some of their recommendations than others. A June 19 alert warning of unreported latencies in Nexrad images deserves the attention of every pilot who'd like to use this technology to help avoid violent weather.

This alert was motivated in part by the [in-flight break-up of a Piper Cherokee Six \(PA32-260\) near Bryan, Texas](#), some six months earlier. In the late afternoon of Dec. 19, 2011, the Cherokee made a fuel stop at the Jackson-Evers International Airport in Jackson, Miss., en route from Hampton, Ga., to the TSTC Waco Airport outside Waco, Texas. It took off on the final leg about 10 minutes before 6 p.m. Four passengers were on board along with the 400-hour instrument-rated private pilot.

The first two and a half hours were uneventful. However, weather was starting to build in east and central Texas, the result of an outflow boundary extending from the Houston area into the northeast corner of the state. The air throughout the region was warm and moist, with temperature/dew point spreads of three degrees or less, and the instability triggered by the outflow created "a moist conditionally unstable environment, which would have been supportive of cloud formation, rain showers, and thunderstorms." Two convective sigmets were in effect.

At 9:19 p.m., the pilot checked in with Houston Tracon, reporting that he was level at 8,000 feet. The controller advised that he could hold his present heading

for about another 40 miles, after which he should expect to turn right. The pilot acknowledged and added, "I was looking at my Nexrad, is up ahead ... taking about a two-five-zero heading for a little while, that be all right?" The controller replied, "that two-fifty will put you in some moderate to heavy precip" and suggested that about 20 miles north of College Station, "you can start bending it to the right, there is some pretty good gaps in the weather once you get around that area." Thirteen minutes later the controller advised the pilot that radar showed the Cherokee skirting an area of light to moderate precipitation. The pilot replied that he saw the same thing and was maneuvering south to find a hole through the showers.

Just one minute later, the controller warned of a "heavy to extreme cell at your one to two o'clock and about eight miles." The pilot acknowledged, adding, "If it's all right with you we will hold this heading right here until we get south of that." The controller approved the request; four minutes later, he asked the pilot if he was "getting any lightning" off his right side. The pilot was not, but altered course another 15 degrees to the left, saying that his display showed "a pretty good storm" off to his right. Once clear of that, he'd make his right turn toward Waco.

It was about five more minutes before the controller contacted the pilot again, this time to warn of "pretty heavy weather" moving to the northeast. He then said "It looks like you just made a left three-sixty on me; what's going on? ... I show you headed right into heavy weather, now uh I would suggest you turn back right to about a two-two-zero heading." The pilot's final transmission was, "Okay, yeah, we're turning right. We're in some bad weather here. I'm going to try to get out of it." Radar contact was lost two minutes later; the left wing was found 50 yards from the rest of the wreckage. The main spar had been broken upward at the root. Metallurgic analysis attributed the failure to overload, not fatigue.

Overlaying radar track data on the precipitation echoes showed that the Cherokee's southwest course had converged with an area of "strong to intense" echoes moving northeastward. The last radar contact with the aircraft came in an

area of “very strong to intense echoes.” However, the most recent Nexrad mosaic available to the pilot was based on images acquired more than eight minutes earlier. The investigators also noted that the display in the cockpit would not have made this obvious. The time stamp shown on the radar mosaic was the time at which the mosaic had been assembled; the individual site images from which it was built could, on occasion, be as much as 15 minutes older.

Eight minutes may not sound like much, but it’s plenty of time for a normally aspirated piston single to fly another 15 miles—enough to obliterate the recommended 20-mile buffer from thunderstorm cells that were themselves moving at 45 knots. The time lag is one reason in-cockpit radar downloads, helpful as they are in avoiding areas of bad weather altogether, aren’t up to the challenge of finding a way between cells in the dark.

# #4 NO HORIZONS

By David Jack Kenny

It's become a cliché to define insanity as “doing the same thing over and over while expecting a different result.” Still, by that standard general aviation as a community remains painfully deluded, however admirable the cognitive processes of most individual practitioners. Name the crucial mistake, and it will be repeated by some small percentage of aviators year after year after year, no matter how widely previous examples have been discussed and lamented.

Just after midnight on Aug. 10, 2015, the pilot of a rented 1973 Piper Arrow taxied out to Runway 25 at the [Marathon Airport](#) in the Florida Keys. The night was calm and clear but dark: The sun had set four hours earlier and the moon three hours before that. The solo private pilot had received his complex endorsement in May and completed a flight review the previous December. He did not have an instrument rating. The last available measure of his flight experience was a medical application filed nearly a year and a half earlier, which listed 125 hours. The extent of his experience flying at night is not known, but the rental agreement he'd signed with the airplane's operator prohibited “any night flights to or from the Bahamas or the Florida Keys before sunrise or after sunset.” His reasons for ignoring that provision are not known: He'd retired from his first career a year earlier, and the airplane wasn't due back for another day.

Footage from the airport's security cameras showed the Arrow accelerate on the takeoff roll, lift off, and climb out on the upwind. Shortly after it turned crosswind, its lights disappeared from view. The same footage “revealed the absence of any visible horizon to the northwest of the airport.” Two boaters nearby saw the Arrow descend into the water and reached the scene in time to pull its unconscious pilot from the water. He was pronounced dead by first responders as soon as they reached the shore.

The wreckage was found “in numerous pieces” in nine feet of water with “impact and crush damage to both wings, cabin, and fuselage.” Examination found no evidence of fuel contamination or any failure of the flight controls, engine, vacuum pump, or instruments prior to impact. Toxicology results showed that the pilot had not been impaired by drugs or alcohol. Not surprisingly, the NTSB concluded that the accident resulted from “spatial disorientation while turning after takeoff in dark night conditions,” and the ensuing discussion made particular note of the somatogravic illusions that can afflict a pilot deprived of visual references. In particular, leveling the wings after a turn is easily mistaken for a turn in the opposite direction, leading the pilot to steepen the original bank in the attempt to recover.

Night departures over bodies of water are particularly subject to this hazard, and it isn't just low-time VFR pilots who are at risk. The pilot of the Cessna T206H that crashed into the Gulf of Mexico just after a night takeoff from [Cedar Key](#) in June 2008 had a commercial certificate, instrument rating, and almost 1,500 hours of flight time. Five months before that, a Model 58 Beech Baron went down in Lake Erie just after taking off from [Cleveland's Burke Lakefront Airport](#) after dark. At the controls was an airline transport pilot with some 18,600 hours of experience. In both cases, the NTSB concluded that the pilots' failure to make an immediate transition to instrument flight after lifting off led to spatial disorientation.

The hazards of attempting VFR flight over water at night have been known to the aviation community for decades. The 1999 Kennedy/Bessette accident brought them to the attention of the wider public (with some of the misrepresentations and distortions that typically accompany coverage of technical subjects by the popular press). Less widely discussed but no less real are how greatly those risks are magnified when the flight involves low-altitude maneuvering—as in a traffic pattern—in an environment with no visible horizons.

Worksheet:

Identify risks (i.e. Hazards)

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Assess risks (i.e. Severity and Likelihood)

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Risk Assessment Matrix				
Likelihood	Severity			
	Catastrophic	Critical	Marginal	Negligible
Probable	High	High	Serious	
Occasional	High	Serious		
Remote	Serious	Medium		Low
Improbable				

Analyze controls

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Make control decisions

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Use control decisions

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Monitor results