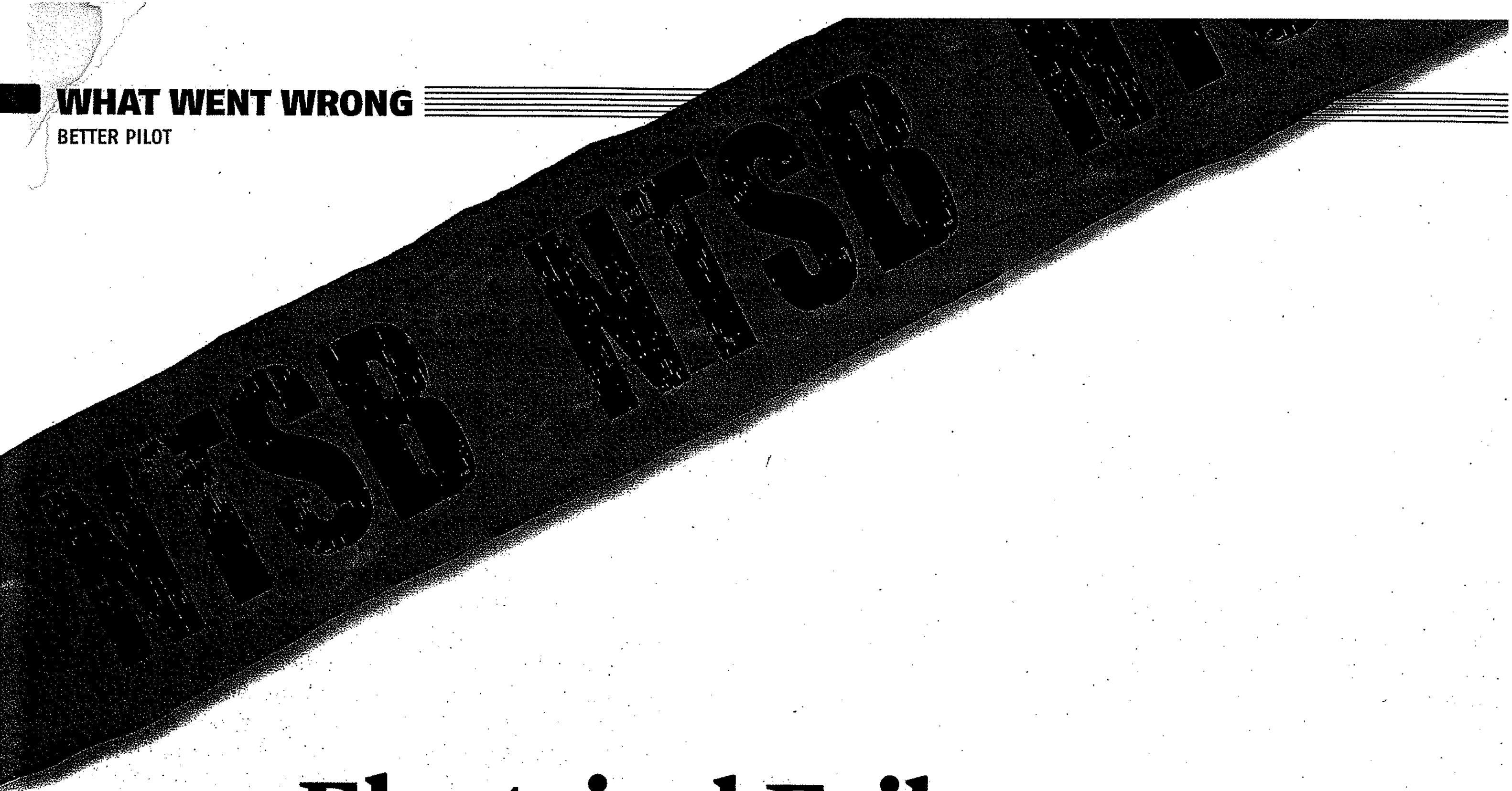

Electrical Failure

BY J. MAC MCCLELLAN

IN MOST PISTON-POWERED AIRPLANES electrical failures do not usually create a true emergency. The magnetos are rotated by the engine so spark ignition continues even if all normal electrical power fails. And fuel-injected engines that require fuel pressure to operate are fed by an engine-driven pump so the electrical pumps are for standby use.

At night or in the clouds an electrical failure can quickly become critical because lighting and essential flight instruments will be lost. But the prudent pilot carries backup flashlights to see the instruments under night VFR if the lights go out, and the important flight instruments such as the gyro horizon require independent power source backup for IFR flight. And many of us carry handheld comm radios as backup.

Some piston airplanes are, however, more dependent on the electrical system than most, and the E-AB Lancair 235 is one of those.

It's impossible to say exactly how every Lancair 235 is wired because being E-AB, each is an individual, and kit builders can make modifications as they see fit. However, because Lancair sells a very complete kit, most finished airplanes are pretty similar.

The Lancair in question was issued its special amateur-built airworthiness certificate in 2006 and sold to a new owner almost exactly two years later. The airplane had flown 238 hours when it underwent its most recent conditional inspection about 11 months before the accident. The Lycoming O-235 engine had logged just more than 432 hours since overhaul at the time.

The new owner of the Lancair was a private pilot with 484 hours of total experience. The NTSB report does not list his time in the Lancair, but he had owned it for more than four years. He also had an instrument rating, though the NTSB does not say if he flew the Lancair IFR.

The Lancair used electrical power to operate the retractable landing gear, extend and retract the wing flaps, control the pitch of the propeller, and move fuel from the wing tanks to the header tank that supplied fuel to the engine. Electrical power was also used for other typical tasks such as operating the fuel gauges, lights, avionics, and other cockpit instruments.

The landing gear retraction mechanism used an electrically powered hydraulic power pack. An electric motor energized a hydraulic pump to raise and lower the gear. Hydraulic power was not used in any other airplane system. This type of dedicated landing gear hydraulic power pack is very common in production retractable-gear airplanes.

A jackscrew mechanism rotated by an electric motor extended and retracted the wing flaps. Without electrical power it was not possible to change the position of the flaps.

Electrically powered propeller pitch control was common many years ago, but hydraulic actuation with engine oil pressure providing the pressure is now the norm. But this Lancair was equipped with an MT propeller that uses an electric motor to adjust blade pitch. The propeller had a governor system allowing the pilot to select "automatic," which caused the governor to hold a constant propeller rpm. There was also a "manual" mode that used a switch to select a desired blade pitch angle. If electrical power failed, the propeller blades remained in their present pitch.

Another uncommon system in the Lancair is the use of electric pumps to transport fuel from the wing tanks to the header tank located ahead of the instrument panel. In most low-wing airplanes the engine-driven pump can suction feed fuel from the wings to the engine. In the Lancair only electric transfer pumps can move fuel from the 33-gallon wing tanks to the 11-gallon header tank where it could then flow to the engine. Lancair's operating recommendations are to not take off with less than 8 gallons of fuel in the header tank for the obvious reason that the transfer pumps could fail, or electrical power could be lost.

As you can see, it was a pretty big deal when the Lancair owner began to have intermittent electrical problems about two months before the accident. He told others that he had moved the switch to extend the landing gear, but nothing happened. After a short time, the hydraulic motor turned on and powered the landing gear down.

There is no mention of problems retracting the Lancair gear in the NTSB accident report, but the pilot told others that the gear-extension issues continued on each flight. Apparently he couldn't identify a cause for the problem, but he found that if he turned off all non-essential electrical equipment before extending the gear, that seemed to help. Once the gear was down he would turn the other electrical equipment back on.

On the morning of the accident the Lancair pilot made a short 60-mile flight from his home airport to have breakfast with fellow pilots. On this flight the landing gear would not come down even with other electrical equipment turned off. But he was able to reach the main battery cables behind his seat, he jiggled them, and the electrical system came back to life and the gear extended.

After breakfast when it was time to return to his home airport the Lancair wouldn't start. He had a friend hand-prop the engine, and it started. However, the electric propeller pitch control was dead, and he couldn't get the prop to adjust from the low rpm coarse pitch to the fine pitch necessary to take off. He shut down, removed the aircraft battery, and returned to his home airport with another pilot.

Back home he charged up two batteries, and a friend flew him back to his Lancair with both batteries. He told his friend if he could get the airplane running and the propeller correctly set, he would fly home with the landing gear extended. If he had an electrical failure along the way, the plan was to continue with his friend as a flight of two so they could land at the tower-controlled home airport.

According to the NTSB report the Lancair pilot's friend told him that if the airplane started but he did not get a positive charge indication to shut it down. The Lancair pilot "blew him off."

After three tries the Lancair engine started, the pilot gave his friend a "thumbs-up," and taxied to the active. The Lancair pilot paused only six or seven seconds at the runway at the uncontrolled field and then took off. Fuel was seen running out of the right wingtip vent when the Lancair turned while taxiing.

It took the Lancair pilot's friend three to four minutes to get into the air, and not long after takeoff he heard the Lancair pilot calling him on the airport UNICOM frequency. The Lancair pilot was using a handheld radio, not the normal radios, and his friend told NTSB investigators he could tell from the pilot's voice that something was wrong.

The Lancair pilot radioed his friend a position near an airport but said he was going to land in a field, not on the runway. The Lancair pilot's last communication was, "I'm coming in hard."

His friend arrived over the last reported position but couldn't see the Lancair on the ground. But he did hear an ELT transmission so he landed and called 911. A witness on the ground told investigators that he saw the Lancair flying level but could not hear any engine sound. The Lancair disappeared behind a low hill, then climbed into view again, turned right to miss a barn, and then disappeared behind terrain again. The witness then heard the sound of impact.

The Lancair cleared trees that were about 30 feet tall and hit in a level attitude in a field where the corn had already been harvested. The landing gear collapsed; after sliding 63 feet the Lancair nosed over, tumbled, and came to rest with the fuselage broken into three pieces and both wings separated from their mounting locations. The pilot was killed.

Investigators couldn't find any evidence of pre-impact problems with the engine. It was equipped with an Ellison Fluid Systems throttle body injector in place of the original carburetor. The Ellison and the engine-driven fuel pump that supplies fuel to it remained attached to the engine. Only small amounts of fuel were found in the throttle body injector, the fuel pump, and the hose that connected them. The fuel pump operated normally when actuated by hand, and no debris was in the throttle body fuel inlet screen.

The NTSB reports that about 8 ounces of fuel was in the header tank that supplied the engine, and only trace amounts of avgas were in the fuel filter and fuel strainer. Both wing tanks were breached in the crash, but there was evidence of fuel and all fuel caps were closed and locked. A study of fuel purchase records couldn't determine how much fuel was onboard at takeoff, but the NTSB points to fuel seen running from the wingtip fuel vent as evidence that fuel was in the wing tanks at takeoff.

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In hindsight you can see how the electrical failure could cascade into a critical situation in the Lancair. Without electrical power the pilot couldn't move fuel from the wings to the header tank and thus to the engine. If he had lost track of how much fuel was in the header tank before takeoff, he could have had only minutes of usable fuel available even though sufficient fuel was in the wings.

Without electrical power the Lancair pilot could not have changed propeller blade pitch from takeoff fine pitch to low rpm course pitch, which would have extended glide distance. The reduced drag of a slower-turning propeller is not enormous, but does make a difference.

But the most critical issue in the forced landing without electrical power was the inability to lower the wing flaps. The flaps on the Lancair are very effective in reducing the stall speed and thus lowering the amount of energy that must be dissipated at impact. The NTSB quotes Lancair performance specifications that say stall speed drops from 61 knots flaps-up to 48 knots flaps-down. That 13-knot difference in forced landing approach speed equals an enormous amount of energy that the Lancair carried to touchdown.

NTSB investigators examined and tested the significant components of the electrical system including the alternator, voltage regulator, starter relay, and master relay, and everything functioned normally. Overall the wires and connectors showed no evidence of pre-impact failure.

Investigators turned their attention to the battery and found significant amounts of corrosion and electrolyte residue inside the composite construction battery box. The battery itself had been ejected by impact and showed some damage but no evidence of pre-impact failures, gassing, or leaking acid. All cell packs were intact, and the electrolyte was fully contained, indicating that the corrosion and residue in the battery box came from a previously installed battery.

Both the positive and negative battery cables were severed by impact, but the positive cable remained attached to the master relay. Investigators found the cable and its connector were wet, only a dozen strands of wire remained in contact, and there was heavy corrosion inside the cable. The other end of the cable that had been attached to the battery was also moist and corroded.

When the NTSB investigators examined the position of the battery and the master relay connector, they found the relay was below the battery and the battery cable was not long enough to form a "drip loop," which would have prevented electrolyte and other liquids from running down the cable and into the base of the connector.

The NTSB probable cause finding for the accident is "The pilot's decision to operate the airplane with known electrical system problems, which resulted in the in-flight failure of the electrical wiring interconnect system, loss of electrical power, and subsequent fuel starvation and loss of engine power." EAA

This article is based solely on the official final NTSB report of the accident and is intended to bring readers' attention to the issues raised in the report. It is not intended to judge or reach any definitive conclusions about the ability or capacity of any person, living or dead, or any aircraft or accessory.

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