ERA12FA280

HISTORY OF FLIGHT

On April 14, 2012, about 1330 central daylight time, an experimental, amateur-built Lancair 235, N235MW was substantially damaged during a forced landing near Hudson, Kentucky. The private pilot was fatally injured. Visual meteorological conditions prevailed and no flight plan was filed for the Title 14 Code of Federal Regulations Part 91 personal flight, which departed from Rough River State Park Airport (2I3), Falls of Rough, Kentucky, destined for Bowman Field Airport (LOU), Louisville, Kentucky.

According to witnesses, approximately 2 months prior to the accident the pilot began to experience electrical issues with the airplane. This was first discovered by him when he went to extend the landing gear on one flight and the landing gear at first did not extend but after hesitating it then extended. This continued to occur every time he flew the airplane, so the pilot would shut off all non essential electrical equipment in the airplane before extending the landing gear and then turn the electrical equipment back on after the landing gear was extended.

On the morning of the accident, the pilot flew from LOU to have breakfast with some fellow pilots. On approach to 2I3, he went to extend the landing gear but, the electrical system failed and it would not come down. He then reached behind his seat, jiggled the airplane's battery cables and was able to restore electricity and lower the landing gear. Later when it was time to depart for LOU, he had someone "hand prop" the airplane for him. After it started he could not get the propeller which was electrically controlled and actuated to come out of coarse pitch (low rpm, cruise setting), so that he could take off. He then shut down, removed the battery from his airplane, and returned to LOU with another pilot.

Once back at LOU a friend lent him a battery charger. The pilot of the accident airplane then charged up two batteries and rode back to 2I3 in the friend's airplane.

The pilot of the accident airplane then installed one of the batteries in his airplane and stated that if he could get it started, he would fly it back to LOU with the landing gear down. His plan, if the radios and electrical system did not work, was for him and his friend to return as a flight of two to LOU.

His friend then advised him that if the airplane started but he did not get a positive indication on the "amp gauge" (ammeter) to "shut it down". The pilot then "blew him off".

The pilot of the accident airplane tried three times to start the airplane before it finally started. He then waved and gave a "thumbs up" to his friend. After taxing to the runway the pilot stopped the airplane for 6 to 7 seconds and then took off. Prior to the takeoff as the airplane made a turn on the taxiway fuel was observed to come out of the right wingtip vent.

His friend then took off, 3 to 4 minutes behind him, and when climbing through 1,700 feet above mean sea level, heard the pilot of the accident airplane ask over the radio if he was still on the frequency. His friend stated that he knew due to the accident pilot's regular phraseology that something was wrong and advised him that he was coming. They were talking on the Unicom frequency for 2I3 and the accident pilot was using a handheld radio rather than the aircraft radios.

The accident pilot stated that he was 1 to 2 miles south of Breckinridge County Airport (I93), Hardinsburg, Kentucky and was going to land in a field. His friend responded “I’m coming as fast as I can”. The pilot of the accident airplane then stated “I’m going in hard”. His friend could hear the emergency locator transmitter transmitting. He then circled the area a few times but could not see the accident pilot or airplane, so he landed at I93 and called 911.

According to a witness, just prior to the accident, he observed the airplane traveling southeast in a straight line. He could not hear any engine noise. It then disappeared behind a rise in the terrain and then reappeared. The airplane then climbed momentarily, turned right missing a barn, and then disappeared once again behind a rise in the terrain. Moments later the sound of impact was heard.

PERSONNEL INFORMATION

According to Federal Aviation Administration (FAA) records, the pilot held a private pilot certificate with ratings for airplane single-engine land and instrument airplane. His most recent FAA third-class medical certificate was issued on July 18, 2011.

According to pilot records, he had accrued approximately 484 hours of total flight experience.

AIRCRAFT INFORMATION

The accident aircraft was a single engine, propeller driven, low wing monoplane of composite construction. It was assembled from a kit and was constructed of temperature cured prepreg E-glass skins over a high temperature honey-comb core.

The aileron and elevators were controlled through push-pull tubes. The rudder control was via stainless steel cables.

It was powered by a 4-cylinder, 118 horsepower, Lycoming O-235-L2C engine equipped with an Ellison EFS-3A throttle body fuel injection system, and a three bladed, MTV-7-F, constant speed, variable pitch propeller.

Range was 869 nm. The airplane could cruise at 182 knots, and would stall at 61 knots in the clean configuration (wing flaps up), and would stall at 48 knots with the wing flaps fully extended. It could climb at 1,550 feet per minute. Ceiling was 20,000 feet. Takeoff distance was 1,250 feet and landing distance was 1,380 feet.

According to FAA and aircraft maintenance records, the airplane's special airworthiness certificate was issued on February 18, 2006, and it was purchased by the pilot on February 28, 2008.

The airplane's most recent conditional inspection was completed on May 11, 2011. At the time of the inspection; the airplane had accrued 238.42 total hours of operation, and the engine had accrued 432.52 hours of operation since major overhaul.

METEOROLOGICAL INFORMATION

The recorded weather at Godman Army Airfield (FTK), Fort Knox, Kentucky located approximately 23 nautical miles east of the accident site, at 1355, included: winds 180 degrees at 15 knots, 10 miles visibility, broken clouds at 8,500 feet, temperature 24 degrees C, dew point 11 degrees C, and an altimeter setting of 30.04 inches of mercury.

WRECKAGE AND IMPACT INFORMATION

The airplane after clearing trees that were approximately 30 feet high, struck the ground in a level attitude in a corn field where the corn had already been harvested. The landing gear collapsed and the airplane then traveled 63 feet on a 124 degree heading before nosing over, tumbling, and coming to rest.

Examination of the accident site revealed that the majority of the airplane was co-located where the airplane came to rest. The fuselage had broken into three pieces, and both wings had separated from their mounting locations. Multiple lighter pieces of the airplane including the right aileron, left elevator balance weight, left landing gear door, and nose gear door were located along the ground scar that led from the initial impact location to the main wreckage. The canopy and other lighter portions of the airplane and its systems were spread throughout the cornfield.

Examination of the cockpit revealed that the magneto switch was in the "BOTH" position, the landing gear handle was in the "DOWN" position, the split rocker master switch was in the "ON" position, and the avionics master switch was in the "ON" position. Both the fuel boost pump and fuel transfer switches were in the "OFF" position.

The throttle was found in the full open position, and the mixture control was approximately 1 inch out from the full rich position. The primer was in and locked.

Airframe and Flight Controls Examination

Examination of the airframe and flight controls did not reveal any evidence of any preimpact failure or malfunction. All of the major components of the airframe were present at the accident site and control continuity was established from the ailerons, elevator, and rudder to the cockpit.

Engine Examination

Examination of the engine revealed no evidence of any preimpact malfunctions or failures.

The engine was found to be lying nose low on its left side and had remained attached to the tubular engine mount. The No.1 cylinder exhaust pipe was impact damaged and the engine induction air box was crushed.

The engine drive train was rotated by turning the propeller hub and continuity of the crankshaft to the rear gears, and to the valve train, was confirmed. Spark was produced from all 8 ignition leads, and compression and suction were observed from all 4 cylinders. Oil was present in the rocker boxes, and oil sump.

The Ellison Fluid Systems throttle body injector and the engine driven fuel pump had remained attached to the engine. A small amount of fuel was observed in the engine driven fuel pump, the hose from the pump to the throttle body injector, and in the throttle body injector. The engine driven fuel pump produced air when actuated by hand. The engine driven fuel pump actuator plunger was felt to move as the engine crankshaft was rotated, and no debris was present in the throttle body fuel inlet screen.

TESTS AND RESEARCH

Fuel and Fuel System

Review of fueling records indicated that the airplane had last been refueled with 21.66 gallons of aviation gasoline at Capital City Airport (FFT), Frankfort, Kentucky on March 5, 2012. Witness statements also revealed that fuel was observed to come out of the right wing tip fuel vent during a turn on the taxiway at 2I3 indicating that fuel had been present in the wing tanks prior to the accident.

The engine driven fuel pump received its fuel from an 11 gallon capacity header tank located behind the instrument panel. An inline fuel filter and fuel strainer were located upstream of the pump. The header tank was fed independently from either the left or right 33 gallon capacity wing tanks by electrically operated fuel pumps which received their electrical power from the main electrical bus. Each wing tank had a filter at its outlet and the fuel was pumped directly into the header tank. The left and right fuel transfer pumps were independent, pilot operated, and could be used to control roll trim.

Examination of the fuel system revealed that the header tank contained about 8 ounces of fuel, and the inline filter and fuel strainer contained only trace amounts of fuel. Both wing tanks had been compromised however when the wings and fuselage were moved for examination a slight smell of fuel could be detected. All of the fuel caps were in the closed and locked position.

Review of the Lancair 235 Pilot Operating Handbook (POH), revealed that takeoff should not occur with less than 8 gallons of fuel in the header tank since the engine was supplied fuel solely from the header tank.

Wing Flaps

The wing flaps were electrically operated and received electrical power from the main electrical buss. A linear actuator (a two way electric motor driving a jack screw) was located in the lower console. Attached to the actuator shaft was a limit switch assembly which contained limit switches for full up and full down. These switches were used to determine the extreme flap positions. Partial flaps were obtained by the pilot by simply timing the actuation of the switch. For example, a "count" of 5 would generally result in approach flaps.

Examination of the wing flaps revealed that they were in the up position.

Landing Gear

Operation of the landing gear was by a self contained hydraulic system driven by an electric motor which received its electrical power from the main electrical buss. The main landing gear was of a trailing arm type and was fully retractable. In the fully extended position, the gear linkage was over-centered. In the retracted position the landing gear was held up by system pressure. Retracting the landing gear was accomplished by moving the electrically powered landing gear switch into the gear up position. This would initiate a pressure buildup by the hydraulic pump, unlock the over- center links and raise the landing gear, each leg of which had its own hydraulic strut with its own limit switches. Extending the landing gear was accomplished by moving the electrically powered landing gear switch into the gear down position. This would initiate the low pressure side of the hydraulic pump and this pressure would lower the landing gear.

Examination of the landing gear revealed that it was in the down position.

Propeller

The electrically controlled variable pitch propeller received its electrical power from the main electrical bus. The pitch change mechanism was actuated by a threaded spindle which would move a fork axially. The spindle was turned by an electric motor. Pitch change blocks moving in the slots of the fork connected the blade pitch change pins with the fork. This transferred the axial movement into a turning motion.

The propeller control unit had two operating modes: "Automatic" and "Manual". A selector switch was installed that enabled the pilot to switch between the two modes. A dial selector was also installed that allowed the pilot to set the desired rpm when the propeller control unit was operating in the automatic mode. A green light would indicate low pitch position for takeoff. The normal operation mode was in automatic where the rpm was kept constant during flight. In case of an electrical failure, the propeller blades would remain at their present blade pitch angle.

Examination of the propeller revealed that it had remained attached to the crankshaft flange. The spinner was fragmented and the propeller blades were impact damaged. Two of the three composite propeller blades were separated from the propeller hub at the blade roots. The third blade was broken mid span and was bent back but remained attached to the propeller hub.

Examination of the propeller control unit revealed that it was in the "AUTO" position and the RPM dial selector was in the 2700 rpm (Takeoff, fine pitch) position.

Electrical System

The accident airplane's electrical system consisted of an alternator, voltage regulator, and a battery. The alternator provided power to the main electrical buss and the battery. A separate avionics bus was also installed and was controlled by an avionics master switch.

Control of the electrical system by the pilot was through the split master switch. One half was labeled "BAT" and the other half was labeled "ALT". Turning off the ALT side of the switch would take the alternator off line allowing the battery to be on-line without the alternator. Operation of the alternator without the battery on the line however, was not possible.

The alternator would convert alternating current to direct current (DC) for charging the battery. Its DC voltage output was 14.2 to 14.8 volts. Field excitation of the alternator was provided by the battery. Examination of the alternator revealed that it was impact damaged and that when rotated by hand would exhibit binding. Testing revealed however that when connected to a test unit that it was functional. It would output approximately 14 volts.

The voltage regulator would regulate the charging voltage that the alternator produced keeping it between 13.5 and 14.5 volts to recharge the battery and to protect the airplane's electrical components. Testing of the voltage regulator revealed that it was functional and that it would peak at 14 volts.

The starter relay was used to relay power to the starter from the battery. Testing revealed that it was functional. It would close at 5 volts and open at 2 volts.

The master relay was used to relay power from the battery to the electrical system. Examination revealed that the top of its case showed evidence of it having been exposed to electrolyte and that a connector from the positive battery cable was still attached to one of the terminals. Testing revealed that it was functional. It would close at 5 volts and open at 2 volts.

Battery and Battery Box Examination

The battery which was normally secured inside a battery box in the aft fuselage had been ejected from the airplane's battery box during the impact sequence and was found lying on its side in the corn field. The battery was used for storage of electrical energy for starting the engine, powering the electrical system, and as an electrical equalizer, protecting the airplane from transient electrical charges.

On-scene examination of the battery revealed indentations and holes in the plastic battery case with characteristics that appeared similar to chemical and soot stains. A short length of battery cable was still attached to the positive terminal by a battery connector. Further on-scene examination revealed that the other end of the battery cable was missing its connector, and that the negative terminal on the battery was broken off.

Examination of the battery box revealed that it was of composite construction, was discolored, and a significant amount of corrosion and electrolyte residue was present.

Further examination of the battery revealed that the indentations and holes in the battery case which appeared to be chemical and soot stains were in actuality discolorations of the plastic from stress marks consistent with impact damage.

No evidence of preimpact malfunction or failure was discovered, and internal examination revealed that the valves were all in place, were properly seated, and the area was dry with no indication of acid or gassing.

Visual examination of the top lead within the battery revealed that the terminal straps were twisted and the positive terminal was bent. However, the straps and terminals were intact and functional with no breaks or shorts, other than the visible break of the negative terminal stud.

Open Circuit Voltage (OCV) of the battery was measured and was found to be 10.8 volts (V). OCV measurements of the six individual cells (measured from the positive end of the battery) were: 1.989V, 1.963V, 0.931V, 1.983V, and 1.929V. The third cell, which had the lowest OCV (0.931V), had one of the holes through the case. This was consistent with the cell having been exposed to air, as oxygen ingress has the effect of discharging the negative electrode and lowering the cell voltage in valve regulated lead acid batteries, and the battery having been discharged during multiple start attempts without opportunity for recharging.

Examination of the cell packs revealed that they were intact and that the electrolyte was still fully contained within the separator paper of the cell packs indicating that the corrosion and residue in the battery box was not from this battery and was from a previously installed one.

Electrical Wiring Interconnect System

Examination of the electrical wiring interconnect system revealed that the majority of the connectors in the airplane displayed no evidence of any preimpact failure or malfunction. However, during examination of the connector that was separated from the positive battery cable, and was still connected to the master relay, it was discovered that the inside of the connector's collar which had been originally soldered and crimped on to the battery cable, was moist, heavily corroded, and had only 12 of the battery cable's wire strands in contact with the collar of the connector. Further examination revealed that the battery cable end which had been retained by the connector's collar was also moist, and exhibited significant corrosion. Additionally, comparison of the position of the positive battery cable's run from the battery terminal to the master contactor revealed that the master relay's mounting location placed it below the top of the battery and the cable was not of sufficient length to include a drip loop, which would prevent electrolyte and other liquids from running down the cable into the base of the connector, which was only covered with a loose fitting plastic sleeve.

Fuel Transfer Pumps and Emergency Procedures

Review of the POH revealed that in order to transfer fuel to the header tank, electrical energy was required to operate the fuel transfer pumps.

Electrical energy was also required to perform among others, the emergency procedures for:

- "ENGINE FAILURE": Which required the fuel pump to be "ON", the transfer pumps to be "ON", the engine starter if time permitted, the wing flaps when on final to be "FULL".

- "EMERGENCY DESCENT": Which required the Propeller to be set to "HIGH RPM", and the landing gear to be moved to the "DOWN" position.

- "MAXIMUM GLIDE CONFIGURATION": Which required the landing gear to be moved to the "UP" position, the wing flaps to be moved to the "UP" position, and the propeller to be set to the "LOW RPM" position.

- "LANDING EMERGENCIES" (Landing without engine power): Which required in addition to moving the wing flaps to the "AS REQD" position, required that a landing site be selected and determine whether the landing gear should be "UP" or "DOWN". For instance if the landing was to be made on water, a foamed runway, or "sod", the landing gear would "generally be best left up". If the terrain was harsh, the gear may well absorb energy and although resulting in substantial damage to the airplane may in that process afford some protection to the occupants and therefore be a preferable option.

ADDITIONAL INFORMATION

Aircraft Electrical Systems

Aircraft electrical systems must be highly reliable and fault tolerant. Historically, electrical system failures often result from interconnection breakdowns. Significantly, environmental factors, especially corrosion have been identified as contributors to connector problems. Depending on the severity of the electrical failure the consequences could be various, ranging from isolated system or subsystem malfunctions and navigational problems, to failures having adverse effects on the aircraft's handling and performance.

FAA Advisory Circular (AC) 43.13-1B

According to FAA AC 43.13-1B (Acceptable Methods Techniques and Practices-Aircraft Inspection and Repair), the satisfactory performance of an aircraft is dependent upon the continued reliability of the electrical system. Damaged wiring or equipment in an aircraft, regardless of how minor it may appear to be, cannot be tolerated. Reliability of the system is proportional to the amount of maintenance received and the knowledge of those who perform such maintenance. It is, therefore, important that maintenance be accomplished using the best techniques and practices to minimize the possibility of failure.

Equipment, electrical assemblies, and wiring installations should be inspected for damage, general condition, and proper functioning to ensure the continued satisfactory operation of the electrical system. Electrical systems should be adjusted, repaired, and overhauled, and electrical equipment and systems should be tested in accordance with the recommendations and procedures in the aircraft and/or component manufacturer’s maintenance instructions. Components of the electrical system that are damaged or defective should also be replaced with identical parts, with aircraft manufacturer’s approved equipment, or its equivalent to the original in operating characteristics, mechanical strength, and environmental specifications.

The AC also advises in part to look for problems and check for:

- Damaged, discolored, or overheated equipment, connections, wiring, and installations.

- Poor electrical bonding (broken, disconnected or corroded bonding strap) and grounding, including evidence of corrosion.

- Improper, broken, inadequately supported wiring and conduit, loose connections of terminals, and loose ferrules.

- Poor mechanical or cold solder joints.

FAA Aircraft Electrical Interconnect System Practices Job Aid

FAA's Aircraft Electrical Wiring Interconnect System (EWIS) Best Practices Job Aid also provides guidance regarding EWIS maintenance, advising that chemicals such as hydraulic fluid, battery electrolytes, fuel, corrosion inhibiting compounds, waste system chemicals, cleaning agents, deicing fluids, paint, and soft drinks can contribute to degradation of EWIS. Interconnect systems in the vicinity of these chemicals should be inspected for damage or degradation. Recommended original equipment manufacturer cleaning instructions should be followed.

Terminal lugs and splices are also susceptible to mechanical damage, corrosion, heat damage and chemical contamination and wires and EWIS hardware in the vicinity of all aircraft batteries should be inspected for corrosion and discoloration. Discolored wires should be inspected for serviceability. Corroded wires and/or EWIS hardware should be replaced.

Furthermore, worn environmental seals, loose connectors, excessive corrosion, missing seal plugs, missing dummy contacts, or lack of strain relief on connector grommets can compromise connector integrity and allow contamination to enter the connector, leading to corrosion or grommet degradation. Drip loops should be maintained when connectors are below the level of the harness and tight bends at connectors should be avoided or corrected.

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