National Transportation Safety Board
Aviation Accident Final Report

Location:	Boise, ID	**Accident Number:**	WPR12FA089
Date & Time:	02/03/2012, 0856 MST	**Registration:**	N321LC
Aircraft:	GARZA LANCAIR IV-TP	**Aircraft Damage:**	Destroyed
Defining Event:	Aerodynamic stall/spin	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 91: General Aviation - Personal		

Analysis

The amateur-built, experimental, high-performance airplane was fueled to capacity and the pilot had planned a cross-country flight. During an initial takeoff, the airplane climbed to about 60 feet above ground level (agl) before touching back down; the pilot transmitted to the air traffic controller that he had a problem. The controller asked if the pilot needed any assistance, and the pilot responded that he was going to taxi back and "see if I can figure it out," indicating that there was not a catastrophic failure and the pilot was intending to troubleshoot the problem. The pilot then taxied to a ramp area where the airplane was stationary for almost a minute and a half. Although the pilot's actions during this period are not known, it is likely that he was attempting to troubleshoot a problem with the airplane because the recorded engine parameters are consistent with the pilot cycling the propeller.

Thereafter, the pilot stated his intention to stay in the traffic pattern, and he taxied the airplane back to the runway. The airplane became airborne about 18 seconds into the takeoff; the pilot then made a request to turn back to land. The airplane turned to the left and continued to climb until it reached its peak altitude of about 320 feet agl. Witnesses indicated that the airplane then entered a spin, completed about one revolution, and impacted terrain in a nose-low attitude before coming to rest in a dirt area between the parallel runways. A fire started upon impact.

At the peak of the airborne portion of the first rejected takeoff, about 5,860 feet of runway remained. When the pilot made the request to turn back to land during the second takeoff, over 5,160 feet of runway remained, but because the airplane was 260 feet higher and had a higher airspeed than previously, the pilot likely thought he would not be able to land on the runway surface straight ahead. A performance study indicated that the airplane experienced a loss of thrust during the accident takeoff about 1 second before the pilot's request to return.

Postaccident examination revealed no evidence of a preimpact uncontained engine failure, inflight fire, or flight control system malfunction. Fuel system continuity could not be confirmed due to thermal damage incurred during the postcrash fire. Review of the engine parameters revealed that, during the accident takeoff, the greatest anomaly in the airplane's

parameters was that the fuel pressure dropped to a minimum psi while the fuel flow increased and the torque delivered to the engine shaft (Q) increased excessively. Shortly thereafter, fuel pressure recovered when the fuel flow reduced and Q retarded to an idle setting. Q also dropped to an idle setting during the previous takeoff. The reason for these variations could not be explained. In comparing prior flights to the accident flight, the maximum Q attained during takeoff climb was lower than the Q for the accident takeoff, and the fuel pressure did not drop to the same level as during the accident flight, which are indicative of a problem with the airplane.

The airplane was equipped with a Turbine Starter Limiting/Monitoring System, capable of limiting power by restricting fuel flow, which was designed to act as a start sequence controller, an engine protection limiter, and an engine monitor/recorder. It is possible that this system/installation malfunctioned and engaged during the accident takeoff; however, the system was destroyed in the postcrash fire and could not be examined. Consequently, no determination regarding its performance during the accident flight is possible.

The data showed that the pilot's most recent flight in the airplane was 6 days before the accident, at the same airport. During that flight, he also performed an initial rejected takeoff, suggesting that he was possibly having problems at that time; he made a successful flight thereafter, but remained in the traffic pattern.

A simulation of the accident flight indicated that, during the airplane's left turn, the angle of attack at which the wing stalls was exceeded. A former engineer and general manager of the kit manufacturer stated that if the engine failed during takeoff, the airspeed would rapidly decay, and the pilot would have to push the nose down to maintain flying speed. He noted that following a loss of power, the nose would remain in a nose-up attitude, and unless the pilot made corrective pitch inputs (reducing the angle of attack) within about 4 to 5 seconds, the airplane would rapidly reach a critical angle of attack and stall, which would result in the wing simultaneously dropping. It would not be possible to recover from the stall at altitudes below 1,500 ft agl.

Based on the results of the simulation for the accident flight, witness statements, statements from a former employee of the kit manufacturer, it is likely that pilot was attempting to return to a runway (either the takeoff runway or the parallel runway). The pilot did not push the nose down to maintain flying speed and stalled the airplane well below 1,500 ft agl, and the airplane was spinning when it impacted the ground. Although beyond the end of the takeoff runway was flat, unpopulated hard-dirt surface, suitable for a straight-ahead emergency landing, it is unknown why they pilot chose to return to the airport rather than lower the nose and land there.

Twenty-six percent of Lancair airplanes have been involved in accidents, and 19 percent have been involved in fatal accidents. In 2008 and 2012, the FAA convened two safety groups specifically to address the airplane's "unusually high accident and fatality rate compared to other amateur-built aircraft." The study noted that based on the statistics, the kit was involved in fatal accidents at "a rate that is disproportionate to their fleet size." As a result of studies developed by these safety groups, the FAA acknowledged that accidents would continue to occur if no action was taken. Thus, the FAA issued a notice that Lancair pilots should "review and thoroughly understand all information regarding stall characteristics and obtain

specialized training regarding slow flight handling characteristics, stall recognition, and stall recovery techniques;" install an angle-of-attack indicator to better predict a stall; and have their airplane evaluated by an experienced type-specific mechanic to ensure proper rigging, wing alignment, and weight and balance. The notice was recalled shortly after its release and another notice was released later to include other high-performance experimental amateur-built aircraft.

When asked about what he disliked about the flight characteristics of the airplane, the pilot had told a technician who refueled the airplane that it was "squirrelly." According to the FAA, depending on the complexity of the systems installed, pilots likely will require orientation and specially-tailored training to operate this airplane safely. Although the pilot was properly certificated in accordance with existing Federal Aviation Regulations and his estimated flight experience in the airplane was 13 hours 40 minutes, no evidence was found indicating that the pilot had received flight instruction in the accident airplane model, even though he was aware that insurance companies required him to do so in order to receive coverage.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: A loss or commanded reduction of engine power during the initial climb for reasons that could not be determined because of postaccident impact damage and fire destruction to engine systems and components. Also causal were the pilot's failure to maintain adequate airspeed and airplane control while attempting to return to the runway despite unpopulated, flat terrain immediately ahead that was suitable for an emergency landing; his decision to take off again with a known problem; and his lack of training in the make and model airplane.

Findings

Aircraft	Airspeed - Not attained/maintained (Cause)
Personnel issues	Decision making/judgment - Pilot (Cause) Aircraft control - Pilot (Cause) Training with equipment - Pilot (Cause)
Organizational issues	Adequacy of safety program - FAA/Regulator
Not determined	Not determined - Unknown/Not determined (Cause)

Factual Information

1.0 HISTORY OF FLIGHT

On February 03, 2012, at 0856 mountain standard time, an experimental amateur-built Lancair IV-TP, N321LC, impacted terrain following a loss of control while on the initial takeoff climb from Gowen Field, Boise, Idaho. The airline transport pilot, the sole occupant, was fatally injured, and the airplane was destroyed. The airplane was owned and operated by the pilot under the provisions of 14 Code of Federal Regulations Part 91. The local personal flight was originating from Boise when the accident occurred. Visual meteorological conditions prevailed and no flight plan had been filed.

Numerous witnesses located at the airport observed the airplane on an initial rejected takeoff and on the subsequent accident flight. A majority of them stated that, during the initial rejected takeoff, the airplane departed 10R and climbed to about 5 to 10 feet (ft) above ground level (agl) before touching back down on the runway. The pilot taxied back toward the west end of the airport. Shortly thereafter, the airplane departed 10R again and climbed to about 100 to 200 ft agl. It then began to roll to the left while rapidly losing altitude. The airplane completed about one revolution and impacted terrain in a nose-low attitude. The airplane came to rest in a dirt area between runways 10R and 10L, and a fire started upon impact. Airport personnel responded to the accident and extinguished the fire with a fire suppressant.

The Boise Air Traffic Control (ATC) Facility provided the recorded radio communications between the pilot and controllers. The pilot was initially cleared onto runway 10R and instructed to "line up and wait." About 1 minute later, he was cleared for a departure to the south, and the airplane took off from the 9,760 ft long runway about 0846:38. He transmitted to the controller 40 seconds later that he was going to "land here and stop... we got... we got a problem." An ATC controller asked if he needed any assistance to which he responded by saying, "negative, I'm going to taxi back and see if I can figure it out." About 9 minutes later, he told the controller that he would like to depart and stay in the traffic pattern for a "couple laps." The tower controller cleared the pilot for takeoff at 0854:40, and at 0855:44, the pilot made his last intelligible transmission when he requested that he would "like to turn back in and...uh...land... coming back in...uh...three." An indiscernible transmission was made 9 seconds later that may have been the pilot saying "Boise."

Flight track data recorded from the airplane's onboard global positioning system (GPS) by the onboard Aerosonic Op Technologies Electronic Flight Instrumentation System (EFIS) was extracted from compact flash memory cards recovered from the wreckage. The EFIS data consisted of 23 parameters with 1 sample taken every 5 to 7 seconds. The recorded data covered the last 14 start cycles of the EFIS, and the last start cycle included data from the accident flight and the rejected takeoff immediately preceding the accident flight. The EFIS data for the last start cycle spanned from 0838:03 to 0856:00, or 25 minutes 57 seconds, with the airborne portion of the accident flight consisting of the last 28 seconds, from 0855:32 to 0856:00. Comparing the times of the pilot's radio transmissions (as recorded in the ATC transcript) to the times of events recorded in the EFIS data revealed that the ATC transcript time lags the EFIS time by about 23 seconds. The EFIS times are used in this report, and the times of radio transmissions recorded in the ATC transcript have been adjusted accordingly (by subtracting 23 seconds).

A review of the data (see Figures 01 and 02 in the public docket) revealed that after the engine

started at 0838:39, the airplane made a continuous taxi (as indicated by variations in groundspeed and heading) from 0844:18 to 0846:07, at which point the nose was aligned with the runway heading (around 100 degrees). From 0846:07 to 0846:32, the airplane remained stationary on the centerline about 270 ft from the approach end of the runway with the torque delivered to the engine shaft (Q) remaining around between 13 to 14 percent, consistent with an idle setting.

The airplane began the takeoff roll at 0846:32 and became airborne about 0846:59. The airplane climbed 60 ft over the next 10 seconds to 2,845 ft msl, which was the highest attained altitude on that flight and corresponded to about 3,900 ft from the arrival end of the runway, which equates to about 40-percent down the runway with 5,860 ft remaining. At this time, 0847:09, the airplane had reached 108 kts (the highest airspeed of the flight); the pitch attitude had decreased from 8.1 to 4.4 degrees nose-up; the Interstage Turbine Temperature (ITT) had decreased from 581 degrees to 376 degrees Celsius (C); Q had dropped from 89.6 to 13 percent; and fuel flow dropped from 56 to 20 gph. The pilot transmitted that he was going land, and the airplane touched down around 0847:21. The pilot made a right turn to the south to exit onto taxiway D. The airplane continued northwest along taxiway B, made a turn west to taxiway F, north onto taxiway J, and taxied on the ramp toward the pilot's hangar.

When the airplane was adjacent to the hangar (about 175 ft north of the hangar door), the pilot maneuvered to have the nose on a heading of about 060-degrees. From about 0852:25 to 0853:51, the airplane was stationary, and it is unknown what the pilot's actions were during that 1 minute 26 second period. The engine parameters indicated that the propeller rotation speed (Np) fluctuated from about 1,140 rpm, down to 490 rpm, and then up to 1,614 rpm, which corresponded to Q values of about 14, 29 and 34 percent, respectively.

Thereafter, the pilot taxied back to runway 10R (a 1 minute 4 second trip to the hold-short line) and turned on the centerline about 110 ft from the arrival end of the runway, where the arrival threshold makings were located. The airplane began the takeoff roll at 0855:14 and became airborne about 18 seconds later at 0855:32, which corresponds to being positioned about 1,780 ft from the arrival end of the runway (see Figure 02 in the public docket). Immediately after becoming airborne, between 0855:32 and 0855:44, the fuel pressure dropped from 26 to 15 psi and then to 14 psi; fuel flow increased from about 54 to 65 gph; the airspeed increased from 99 to 104 kts; and Q increased from 104 to 113 percent torque.

At 0855:44, the pilot made his request to turn back to land, and the data began to show significant changes in the recorded parameters at this time. The airplane was in a 12-degree nose-up pitch attitude and had climbed to about 205 ft agl, corresponding to about 4,150 ft from the arrival end of the runway and about 200 ft right of the runway's centerline. The airplane rolled from 1.7 degrees right to 1.6 degrees left; the airspeed increased from 124 to 132 kts; the fuel flow decreased from 65 to 56 gph; the fuel pressure increased from 14 to 31 psi; Q decreased from 113 to 66 percent; and a drop in Np of about 70 rpm was recorded.

The airplane continued to climb for 10 seconds until 0855:54, when it reached about 320 ft agl, the highest altitude attained during the flight. The data revealed that at this point, the airplane was in a 16-degree bank to the left, and it continued to roll to 49 degrees within 6 seconds. Additionally, Q had reduced to 16 percent; ITT dropped to 379 degrees C, the lowest during the entire flight; fuel flow had reduced to 19 gph; the fuel pressure remained around 32 psi; and the gas generator speed (Ng) had reduced to around 62 percent. The last 4 data points, encompassing the last approximate 16 seconds of the flight, revealed that the heading changed

from 107 to 21 degrees, with Q decreasing from 16 to 14 percent. The accident site was located about 400 ft north of the last recorded position.

1.1 PERSONNEL INFORMATION

A review of Federal Aviation Administration (FAA) airman and medical certification records revealed that the pilot, age 51, held an airline transport pilot certificate with category ratings for multiengine land, multiengine sea, and single-engine land airplanes. His certificate was endorsed with a type rating in the Cessna Citation (A/CE-500 and 525S), and he was authorized to act as pilot-in-command in the experimental Hunter Viperjet. He additionally held a private pilot certificate with a single-engine sea airplane rating. The pilot's most recent first-class medical certificate was issued January 2011, with no limitations.

The pilot's personal flight records were not recovered. On his last application for a medical certificate the pilot reported a total flight time of 3,600 hours.

1.1.1 Lancair Familiarity/Experience

The pilot's brother recalled that in August the pilot had looked at and considered purchasing a Lancair IV-TP, but decided against that specific airplane because it was "rough" in appearance. In December, the pilot told his brother that he had found the accident airplane in North Carolina and had been looking for a Lancair IV-TP for several months in an effort to make quick/fast flights. The pilot had written a series of emails trying to determine how to acquire insurance and was told that to obtain insurance he would need to complete a training program for Lancairs, despite his flight experience in turbine high-performance airplanes. The facilities that provide such training reported that they did not receive any inquiries about training from the pilot.

The recorded EFIS data, which included data from the multifunction display (MFD) and primary flight display (PFD) were used to estimate the pilots' total flight time in the Lancair. The pilot received delivery of the airplane on December 31, 2011, and then it was fueled twice on January 3, 2012, first with 43 gallons and then later in the day with 61 gallons. The MFD indicated the airplane was flown in Boise about 40 minutes on December 31 and about 50 minutes on January 2. The airplane completed a 2 hour 30 minute flight from Boise to Sandpoint, Idaho, on January 4 and then returned later that day.

In addition, EFIS data indicates that the airplane completed a roundtrip flight from Boise to Sandpoint, Idaho, totaling about 2 hours and 40 minutes. On January 11, the airplane made a roundtrip from Boise to Richland, Washington, totaling about 2 hours 5 minutes. The following day, the airplane made a roundtrip from Boise to Bullhead City, Arizona totaling about 4 hours 15 minutes. The last flight recorded before the day of the accident flight was on January 28, when the airplane was flown in the traffic pattern in Boise for approximately 40 minutes.

The flight times recorded above sum to 13 hours 40 minutes, are presumed to be the pilot's total flight experience in the Lancair. No evidence was found indicating that the pilot had received flight instruction in the accident airplane or in any other Lancair IV-TP.

1.1.2 Personal History

Over approximately 10 years prior to the accident, media interviews of the pilot appeared in numerous newspapers, magazines, and trade journals. Many of these articles were reviewed and used with NTSB interviews of the pilot's family, friends, and aviation connections to help give insight to the pilot's history. The pilot started his employment at Micron Technology, Inc.,

in 1983 and was promoted 11 times to become the company's president in 1991 and chief executive officer (CEO) in 1994, the position he held at the time of the accident. Various sources indicate that the pilot had owned over 20 airplanes and participated in various airshows.

The pilot was described as having a passion for high-risk recreation. He participated in activities such as motocross, skydiving, race car driving, and flying high-performance airplanes. He had experience flying a variety of airplanes including, but not limited to: Extra 300, Fairchild PT19, Aero L29, Hawker Hunter, Aviat Husky, Boeing Stearman, and Cessna Citation. The pilot was involved in an accident in July 2004, when he was performing an aerobatic maneuver and did not allow adequate clearance from the ground resulting in a collision.

Friends and family of the pilot classified his health as "excellent," and his spouse reported that he did not take any medications nor did he regularly use alcohol. She stated that he slept well and regularly. She estimated that the night prior to the accident, he went to bed around midnight and awoke around 06:00-07:00, which was normally the amount of sleep he would get. She believed he was going to Glendale, Arizona, on the day of the accident, and he had indicated that he would be back to their house in Boise around 1630. The pilot's spouse and brother both indicated that there was nothing different in the pilot's life or big changes that had occurred prior to the accident; he appeared to be in excellent health and regularly exercised. A corporate pilot that flew the Micron Technology, Inc., jet regularly recalled that the pilot returned from Miami, Florida at 1205 the morning of the accident, which was the last time he saw the pilot. The exact time the pilot returned home is unknown.

1.2 AIRPLANE INFORMATION

The Lancair IV-TP is an amateur-built experimental airplane constructed mainly of composite materials. The high-performance, pressurized airplane is equipped with four seats, retractable tricycle landing gear, and traditional flight control surfaces. The accident airplane received a special airworthiness certificate in the experimental category for the purpose of being operated as an amateur-built aircraft in March 2007. The builder started construction of the aircraft in November 2004 and completed the aircraft in January 2007. The equipment on the airplane was not a standard Lancair installation for a IV-TP, rather, a firewall forward package provided by an outside supplier (not Lancair); Walter/General Eclectic M601E was the standard installation.

The airplane was equipped with a Diemech Turbines, Inc. M601D engine, serial number (s/n) 864030, and, according to the manufacturer, is rated at 724 shaft horse power (SHP). The Diemech M601D is a two-spool engine consisting of a gas generator which drives a power turbine which drives a reduction gearbox. The gas generator compressor is a mixed configuration consisting of two axial flow stages and one centrifugal stage. Inlet air enters the compressor section radially just forward of the accessory section and travels forward through the two axial stages and one centrifugal stage. The exiting compressor air enters an annular combustor arrangement for mixing with fuel for the combustion process. The expanded flow path gases are then directed to the gas generator turbine by the gas generator turbine nozzles. The remaining expanded flow path gases exiting the gas generator are then directed to the power turbine for the final power extraction before exiting the engine forward of the compressor inlet.

The power turbine then drives the propeller system by means of the reduction gearbox. The accessory gearbox which is located on the aft end of the engine drives all engine accessories by a direct shaft coming from the compressor spool. Typical engine accessories are the main fuel pump, fuel control unit, starter / generator which are all on the rear gearbox and the propeller governor, which is driven by the reduction gearbox located at the front of the engine.

The airplane was equipped with a constant-speed three-bladed Avia Propeller V508/E/84/B2 (s/n 120651110), that was manufactured in 1981; the blades were 84 inches in length. The propeller governor was a Jihostroj LUN7815.02-8 (s/n 853059), and the overspeed governor (limiter) was a Jihostroj 065-2600 (s/n 903-071).

1.2.1 Maintenance Records

The airplane's maintenance records were obtained from the pilot's hangar, where they were located with maintenance-related documents/manuals for his other airplanes. In addition, information was obtained from the FAA and Jihostroj Aero Technology and Hydraulics, the manufacturer of the fuel control unit (FCU) installed on the airplane.

According to the records examined, the airplane, serial number 003, had accumulated a total time in service of about 375 hours when the pilot purchased it on December 31, 2011. The most recent condition inspection was recorded as completed on April 11, 2011, at a total time of 339.3 hours. During that inspection, it was noted that the airplane was modified with removable rudder pedals (co-pilot seat) and the outside air temperature (OAT) probe was relocated to the bottom of the right wing tip, where the winglet is affixed to the right wing. According to the logbooks, the most recent maintenance was performed on June 27, 2011, and consisted of an interior "refurbishment" which included these noted maintenance actions: the interior panels and seats being reupholstered in leather, replacement of the carpet, seatbelt re-webbed.

A review of the airplane's documents further revealed that the Diemech Turbines, Inc. M601D engine was originally manufactured in 1986 as a Walter 601D and was installed on the airframe with a time in service of 2,950 hours; the last major overhaul occurred before the engine was installed on the accident airframe. The logbook indicated that on April 04, 2011, the engine was inspected in accordance with the Turbine Power Technology 300-hour scope sheet at a tachometer time of 339.3 hours. The Turbine Starter Limiting/Monitoring System (TSLM) recorded the engine total time (since being installed on the airframe) at the time of the accident as 387.5 hours, equating to 387 cycles.

1.2.2 Configuration/Instrumentation

The engine's SHP at 100-percent Q was 724 SHP and at 112-percent it was 810 SHP. According to Lancair experts, during a normal takeoff rotation speed would be about 75 kts and would be flown about 90-percent Ng. Due to the fast acceleration, a reduced power setting ensures the pilot's ability to operate within limitations. The maximum value of Np was 2,080 rpm.

The engine controls were actuated by three levers located on the center panel of the cockpit. The left lever, the throttle, controlled the power at forward and reverse propeller thrust ratings. The middle lever controlled propeller speed and feathering. The right lever, the condition lever, actuated the fuel shut-off valve and, if the emergency circuit was on, it controlled engine power by metering the fuel flow.

The airplane had fabricated winglets. The avionics package included an Aerosonic Op

Technologies EFIS that was tied to the PFD and MFD and a backup Dynon EFIS. The Op Technologies system enabled the pilot to have visible on the PFD all basic flight instrumentation, a navigation display, and engine instrumentation. Upon application of power, the system would automatically display the airspeed, attitude, altitude, and vertical speed indicators on the upper portion of the screen.

1.2.3 Fuel System

The airplane's fuel system was non-standard for a Lancair IV-TP installation. It was equipped with long range fuel tanks that increased the capacity of the fuel system to 175 gallons and consisted of four fuel tanks: left wing (58 gallons), right wing (58 gallons), aft auxiliary (24 gallons) and the belly (30 gallons). The amount of unusable fuel was 5 gallons. The fuel system included three low-pressure electric fuel pumps, all of which could be activated by the pilot: one main pump and two transfer pumps (rated at 40 to 50 gph and 28-psi).

The aft tank, located behind the pilot's seat, was routed through a transfer pump and check valve to the left wing tank; the fuel was added to this tank via a filler cap on the top of the tank accessed through the baggage door. The left tank fuel pickup was located at the lower wing root and routed to the fuel selector. The belly tank was routed through a transfer pump to the right wing tank. The right tank fuel pickup was located at the lower wing root and routed to the fuel selector.

From the fuel selector, the fuel flow continued via the main electric fuel pump to the pressure header tank. The pressure header tank was comprised of a 1 gallon stainless- steel cylinder with a 10 micron filter affixed to the bottom. The pressure header tank was designed for the fuel to be fed from the electric fuel pump into its main housing and when the fuel pressure was adequate, the fuel would be forced through a 10 micron filter attached to the bottom and continue up through the enclosed center core of the tank. From the tank, the fuel continued by the fuel pressure sensor and then the fuel flow sensor to the fuel control unit (FCU), meaning the pressure and flow displayed on the instrument panel were based on what the pressure header tank was supplying to the FCU. At the top of the header tank was a check valve that ported excess fuel back to the fuel selector, which would then route that fuel to the wing tank that was selected. The fuel selector in turn, had two return lines, one connected to each wing tank.

1.2.4 Prior Issues

The pilot had emailed the airplane's prior owner on January 12, 2012, stating that he had noticed that fuel from the aft fuel tank was feeding slowly to the left wing tank even when the aft fuel pump was not on, which he assumed was due to the fuel valve not closing completely. The pilot additionally stated that it was "not a big deal," but that it had happened on "both flights" he took. On January 18, the pilot emailed the prior owner again stating that the left fuel tank would constantly weep, and fuel would run down the bottom of the wing to the root and drip under the fuselage (near the wheel well). He additionally noted a strong odor of jet fuel from behind the co-pilot seat and queried the prior owner as to his thoughts if the fuel was coming from the aft fuel tank as it feeds to the left fuel tank.

The previous owner responded by stating that he had only experienced the left fuel tank leaking when it was near full fuel. He noted that as for the odor, he was not aware of any reason for the smell of fuel in aft cabin. According to a Lancair IV-TP expert, when full fuel is added to the wings and the air temperature rises, the fuel will trickle through the vents. The fuel will

then follow the wing shape and flow down to the wing root, where there is a fuel odor in the cockpit.

A corporate pilot employed at Micron recalled flying the accident airplane with the pilot on two occasions; he had not flown a Lancair IV-TP before and the purpose of the flights was for him to try flying it. On the first flight the corporate pilot was positioned in the right seat, and they traded off flying while performing a series of touch-and-go practice takeoffs and landings in the Boise traffic pattern. The second flight was later in January, and they flew roundtrip from Boise to Sandpoint. He recalled that while on the ground in Sandpoint, they had folded the left seat back in an effort to store luggage in the rear. In manipulating the seat position, the teeth became misaligned; they were unable to return the seat's position back to upright; and it remained wedged in a reclined 45-50 degree angle. The pilot originally wanted the corporate pilot to fly the return leg, but he could not operate the airplane with the seat that far reclined so the pilot flew back to Boise from the right seat.

From reviewing the pilot's email communications and interviewing his friends and family, it appeared that he was satisfied with the airplane in general.

1.2.5 EFIS Data

The airplane's past EFIS flight data was retrieved in an effort to ascertain the parameter values during the last approximate ten flights. A review of those flights (excluding the accident flight) revealed that during takeoff the following was common:

-Q: the maximum torque attained during the takeoff climb was usually between 80 to 95 percent.

-Pitch: the average maximum pitch was 13-degrees nose-up, with the highest being 18-degrees nose-up.

-Fuel Flow: the fuel flow values varied between 50 to 65gph, with the majority between 50 and 60 gph.

-Fuel Pressure: the fuel pressure values during takeoff varied between 27 to 35 psi, with a majority between 28 to 30 psi. At no time was the fuel pressure recorded as dipping below 25 psi with the exception of one ground run where it momentarily dropped to 0 in conjunction with other parameters not being recorded consistent with the pilot manipulating an electrical power source.

-ITT: the ITT values during takeoff were between 500 to 600 degrees C (According to a Lancair expert, this would normally be between 650-720 degrees C).

-Np: the Np values reached a maximum between 2,000 and 2,080 rpm.

A review of the EFIS flight data additionally disclosed that on January 28, 2012, the last flight prior to the accident flight, the airplane performed a rejected takeoff in Boise. During that flight, the airplane reached a maximum airspeed of 46 kts and likely did not become airborne. The fuel flow during the first 5 seconds dropped from 42 to 18 gph (idle), with the fuel pressure remaining consistent around 30 to 32 psi. Additionally, Np decreased from about 1,970 to 1,245 rpm; Q decreased from 52 to 12 percent; and ITT dropped from 505 to 380 degrees C. The airplane landed and taxied back to the runway, departing again about 2.5 minutes later on an uneventful flight where the pilot performed touch-and-go takeoffs and landings in the traffic pattern.

1.2.6 Fuel Pressure and Fuel Flow

Based on the airplane's records, it is believed that the airplane was equipped with a fuel supply monitoring system (FSM), although the unit was not identified/recovered in the wreckage likely due to the extensive fire damage. The fuel pressure warning was set to be activated at 6 psi. The airplane plans show that it was to be equipped with three fuel flow sensors, each positioned between one of the three fuel pumps and the header tank, although it is not know where in actuality they were located on the airplane. The system was designed to give the pilot a warning indication of a low fuel flow. The low-fuel pressure transducer was fitted to the main fuel pump supplying to the header tank, which was where the low level warning indicator senor was fitted. Given that, during the accident flight, the recorded flows and pressures did not drop below the set parameters, it is not likely the pilot received any such warning.

1.2.7 Fuel Quantity

Local fixed based operator (FBO) personnel fueled the airplane several minutes before engine start on the day of the accident at the pilot's request. A sample of fuel from the truck used to refuel the airplane was obtained, and the refueling technician was interviewed. The EFIS recorded data indicated that both tanks contained 58 gallons of fuel at the start of the initial takeoff attempt, and just prior to the accident (the second takeoff attempt), the right tank contained 54 gallons and the left contained 58 gallons. According to the refueling technician, the pilot had requested that the airplane be refueled to capacity, and the records indicated he purchased 102 gallons of Jet A. The technician recalled filling the wing tanks first, followed by the belly tank and then the aft tank.

1.2.8 Emergency Circuit

The engine was designed with an emergency circuit for engine control if the FCU becomes faulty, and the pilot is unable to control Q with the throttle. The emergency circuit becomes effective by the pilot turning-on the isolating valve (ISOL) switch in the cockpit. To use the emergency circuit, the power should be reduced to idle (via the throttle lever) and the condition lever (right lever) placed in the idle position (normal fuel-on mid-position and labeled). The ISOL switch can then be selected on, and thenceforth the condition lever can be used as a throttle.

Diemech's Operations Manual states that "if a reduction in torque and an increasing ITT occurs, the probable cause would be mechanical" and that "the ISOL will not work and we suggest you land the plane soon." It further states that "if a reduction in torque, N1, and/or ITT occurs and adding of power does not make a change, there is a probable problem with the FCU...," and the pilot should "reduce power to idle (throttle) and make sure the condition lever is in the indent position +/- 1/3 forward." It states that thereafter, the pilot can "select [the] ISOL valve and use condition lever as throttle.

Several Lancair IV-TP owners with many hours of flight experience in the airplane stated that the process of engaging the emergency circuit takes several seconds, and there would likely be insufficient time to activate the ISOL switch and reapply power to the engine if under 500 feet agl. This time limitation is based on the pilot awareness and reaction time, rather than a mechanical limitation.

1.2.9 Weight and Balance

NTSB investigators estimated the airplane's gross take-off weight (GTOW) and center of

gravity. The estimate assumed that the airplane had 112 gallons of Jet A fuel distributed in the wing tanks, and that the belly and aft tanks were full. The GTOW was estimated to be 3,837 pounds, with a center of gravity at 90.13 inches aft of datum. The weight and balance record in the airplane indicated that the maximum allowable takeoff gross weight was 4,300 pounds, and the allowable CG range was from 86.5 to 94.5 inches aft of datum). A sheet detailing the weight and balance computations is appended to this report.

The Lancair-recommended maximum GTOW for a Lancair IV-TP with the turboprop engine and winglets was 3,550 pounds. FAA regulations governing amateur-built aircraft identify the builder as the manufacturer of that individual aircraft and, as such, the builder is allowed to set the weight limits, including maximum GTOW, at any desired value.

Because each aircraft is unique in its construction, the builder must determine the stall speeds for that particular aircraft. Documents relating to the stall speeds specific for the occurrence aircraft were not found during the investigation.

1.2.10 Performance Study

The performance parameters used were based on the recorded EFIS data, and on computer simulations in which the airplane's flight controls were manipulated so as to approximately match the flight path of the airplane recorded in the EFIS Global Positioning System (GPS) data. The simulations used a simple model of the Lancair IV-TP (flaps in the retracted position), a weight of 3,807 lbs (the estimated GTOW less the recorded fuel flow during the flight), and the weather conditions recorded at the time of the accident. The engine power in the simulation was based on recorded propeller speed (Np) and engine torque (Q) data. The complete simulation report is in the contained in the public docket for this accident.

The Lancair IV is an experimental aircraft constructed by individuals from "kits" provided by the designer, Lancair International, Inc. Lancair was not able to provide any usable aerodynamic or performance data with which to construct a simulator model; consequently, the simulator model used in the performance study was based on theoretical aerodynamic relationships grounded in classical aerodynamics and the airplane's geometry; a report of flight tests of another Lancair IV-TP; estimated stall speeds provided to the Transportation Safety Board of Canada (TSB); estimates of angle of attack, lift, and drag based on the recorded PFD/EFIS data from the accident flight of N66HL (NTSB accident # WPR12FA180); and comparisons with other aircraft.

The objectives of the simulation were to:

-obtain a "match" of the recorded EFIS GPS positions using the recorded pitch and roll information and engine power.

-verify the self-consistency of the recorded data by comparing the EFIS data to self-consistent simulation data.

-provide estimates of performance parameters that were not recorded on the EFIS.

-quantify the lift coefficient (CL) required to fly the final maneuver recorded by the EFIS and determine its proximity to CLmax (the value of CL at stall).

Two simulations were conducted, one used a nominal model of propeller efficiency (n) throughout the takeoff, and the second introduced a sudden, artificial drop in n at 0855:43 in an effort to better match the airspeed decay recorded on the EFIS. In both simulations, the

CLmax of 1.3 was reached before the end of the EFIS data, consistent with the airplane's maneuvers resulting in a stall.

The 100% values of shaft horsepower (724 SHP) and Np (2080 rpm) result in a 100% value of torque (Q) of 1,828.1 foot-pounds. Consequently, the actual Q (in ft*lbs) on the propeller shaft could be computed from the percent Q recorded by the EFIS by multiplying by (1,828.1/100). The thrust delivered by the propeller was computed from the computed SHP, the true airspeed, and a model of n. The simulation SHP was limited to the maximum nominal SHP of the engine (724 SHP), even though the NP and Q recorded on the EFIS indicated higher power levels early in the takeoff. The fidelity of the simulations could be improved by allowing the engine to achieve these higher power levels, though the conclusions would not be materially affected.

The EFIS data matched the simulator scenario that included the sudden drop in n at 0855:43 (that reduced the simulation thrust) better than the scenario that did not include a drop in n. The n drop was merely a means for reducing the simulation thrust while preserving the engine power implied by Q and Np values recorded in the EFIS data. It is unknown whether the required drop in thrust indicated a modeling error in the simulation (e.g., an unaccounted-for dependency of the airplane's drag on the power level, etc.), an actual malfunction in the propeller or other part of the propulsion system, or some other phenomenon.

The n-drop simulation was able to follow the EFIS flight track fairly well (until about 08:56:00, when the EFIS recorded a large drop to a pitch angle to -6.7-degrees, which the simulation did not duplicate). The results of the simulation could be used to determine additional information about the flight, such as angle of attack and CL values required to fly the EFIS track. The nominal simulation (without the n-drop), in contrast, started to deviate from the recorded EFIS speed and position data shortly after the pilot's "turn back in" request. These results indicate that the n-drop simulation represented the actual aircraft better than the nominal simulation. The n-drop simulation indicated that the airplane reached the flaps-up CLmax of 1.3 at about 0856:00.

1.2.11 TSLM

The airplane was equipped with a VR Avionics Turbine Starter Limiting/Monitoring System (TSLM). It was designed to act as a start sequence controller, an engine protection limiter, and an engine monitor/recorder. The unit was capable of in-flight power limiting and utilized an analog controller to activate the Electro-Hydraulic Transducer (EHT) valve, which was a component of the electrohydraulic transducer on the FCU. The EHT valve was used to limit the power generated by the engine by restricting the fuel flow.

The electrohydraulic transducer controlled pressure in the compartment of the main metering needle in the FCU and thus the needle's position. Therefore, the fuel supply is dependent on the control signal from the integrated electronic limiter unit. It is designed as an independent subassembly mounted on the FCU body.

Although not identified in the wreckage (due to the post accident fire damage), the airplane should have been equipped with a limiter -disabling toggle switch in the cockpit enabling the pilot to select the limiting function off.

The TSLM's main display in the cockpit (designed to fit in a standard 2.25 inch hole) showed the following 6 parameters in real-time: ITT, N1 (compressor speed), Np, Q, oil pressure and voltage. Each value was given in both numeric decimal and a bar-graph form; if a parameter was exceeded, and therefore subject to being limited, the value would flash. Following a flight,

the data could be extracted and read out on the manufacturer's computer program, TSLM Link., which was the method in which the unit's data was recovered after the accident.

The TSLM's exceedances on the accident unit were set with the following parameters:

Full limiting ITT= 715 degrees

Beta limiting Np= 1900 rpm

Full limiting Compressor rpm (N1)= 101.5 percent

Full limiting Np= 2080 rpm

Full limiting Q = 104 percent

Enable Full (in-flight) limiting= No

Enable beta prop limiting= Yes

The recorded data showed the number of times each of the following exceedances were reached since the engine was overhauled and installed on the airplane:

ITT reached Max ITT= 32

ITT exceeded 800 degrees= 3

Max N1= 1

Max Np= 58

Max Q = 96

According to the manufacturer of the TSLM, exceedance graphs are triggered (recording starts) when one or more of the 6 parameters goes one digit above the set max limit, and recording stops after all 6 parameters have dropped to their max limit or below it for at least 5 seconds. It is thus possible to get multiple parameters exceeding at the same time and end up with only one graph. The ITT exceedance is further monitored at two levels (upper and lower). If an exceeding parameter should dip below its max limit and within 5 seconds go above it again, it would result in another exceedance event/entry grouped with the same graph.

For example, oil pressure on the TSLM is measured to the nearest 1 psi. Thus, with the max limit set at 39 psi, a recording is triggered when oil pressure measures 40 psi or more. Parameters are tested at 100 per second (every 10ms), but recorded at 10 samples per second. Thus within 100ms from reaching 40 psi or more, graph capturing starts. The recording graph stops after oil pressure stays at 39 psi or below for 5 seconds (if no other parameter exceeds during this time).

The system on the airplane was set up so that limiting could only occur while the airplane was on the ground (determined by a squat switch), and/or, the Np limiting could only occur with the propeller in beta. An Np exceedance would only be visible in the cockpit if beta was activated, otherwise it would just show in the recording. If the limiter is limiting, the pilot would see the TSLM light illuminate followed by a reduction of power (the pilot is able to advance the throttle and override the reduction in power).

For the unit to register the propeller in beta, the pilot would have to manipulate the propeller lever back past the flight-idle gate into beta phase, which would ground a microswitch and display beta mode by illuminating a light on the panel. If the microswitch grounded due to a

malfunction in the switches system, the TSLM would perform as if the airplane was in beta and limit Q by restricting fuel. There was no recording/capturing on the TSLM specifically for beta mode or EHT activation unless it occurs while an exceedance recording (abnormal event) is in progress.

Upper ITT exceedances are defaulted to record if the engine reaches in excess of 800 degrees C, and lower ITT exceedances are defaulted to record if the engine reaches in excess of 735 degrees C. A lower exceedance requires borescope inspection, and an upper exceedance requires a teardown inspection. The N1 exceedances were set at 100 percent, and the purpose was to protect the turbine rotors from stretching to the point of serious damage by contacting the engine casing as well as protecting all rotors from encountering catastrophic vibration modes.

The TSLM would show EHT activation via a graph line named "EHT+" (green) that would display TSLM input to indicate a current was flowing in the return wire; the other "EHT" line (blue) would display the output controlled by the TSLM.

1.2.12 TSLM Data

A review was conducted of the airplane's recorded data on the manufacturer's TSLM Link program, which captures the exceedances although the values of the parameters that caused the exceedances are not available (only a graph). The last start before the accident flight was recorded as occurring at 386:37:00, which refers to the total hours, minutes, and seconds that the engine had operated since it was installed on the airplane. At the time of the start of the accident flight, the engine had accumulated 387:13:00 hours. The exceedance summary showed that the engine encountered an Np exceedance at 386:49:27 which continued for about 5 seconds. An oil pressure exceedance occurred at 386:52:00 and continued for about 5 seconds. The last recorded exceedance for that flight was an N1 exceedance, which was the only N1 exceedance ever recorded for the engine. It occurred at 386:57:34 and was recorded as occurring for 5 seconds although the graph showed that N1 was between 77 to 79 percent (with the maximum limit set at 101.5 percent). It is unknown if the exceedances occurred in flight or on the ground. The manufacturer did not know what could cause the trigger of this exceedance graph without the engine reaching that exceedance, although a representative stated that in the field he had seen such exceedance graph histories with erroneous charting (i.e., the exceedance was real, but the data plotted in the chart was erroneous).

The flight on the day of the accident had a start recorded at 387:13:00 and the graph looked similar to the previous start graph. The TSLM recorded six exceedances between this startup and the end of its data, although it was not possible to accurately match the with the EFIS data. The first exceedance was an Np exceedance and recorded as occurring at 387:29:40, equating to 16 minutes and 40 seconds after start and captured 5.5 seconds. The graph displayed that N1 stayed between 92 and 95 percent and ITT oscillated from about 580 to 600 degrees C. Np appeared to peak just above 2,080 RPM (the maximum limit) and level out at 2,000 RPM; the EFIS data showed that about 16 minutes and 40 seconds after the flight the Np was transitioning from 1,114 to 1,774. There were 5 exceedances that occurred thereafter, all of which were ITT exceedances that were recorded as occurring at 387:30:00. The first exceedance was an ITT lower exceedance, the second was an ITT upper exceedance, followed by a lower exceedance with the remaining two being upper exceedances. Of these recorded exceedances, only two graphs were produced, one of which was 24.90 seconds and the other was 22.80 seconds. The longer duration graph showed very little fluctuation in values, and ITT

was recorded as being around 950 degrees C.

The shorter graph showed a rise in ITT from about 470 degrees C up to about 875 degrees C within 0.25 seconds and continued to rise to the same 950 degree C valuation of the longer graph. Additionally, the green EHT+ line indicated that current was flowing to the wire for the first 0.25 seconds that the graph was displaying the recorded parameters.

1.2.13 Handling

The technician that refueled the airplane before the flight stated that while he was rolling up the fuel hose, he conversed with the pilot about the airplane's flight characteristics. He queried the pilot as to what he liked about the airplane, and the pilot responded that the speed capability reached about 300 to 310 kts with a range of about 1,000 to 1,200 miles. When asked what he disliked about the airplane, the pilot noted that it was "squirrelly."

The Micron corporate pilot that had flown with the pilot in the accident airplane stated that he had frequently flown for the pilot in a professional capacity. He had known the pilot about 14 years, but only flew with him for about 15 to 20 hours. Most of that time was the corporate pilot getting checked out to fly one of the pilot's airplanes.

The corporate pilot further stated that the accident airplane was the most responsive airplane he had ever flown. He described the airplane as characteristically having an abundant amount of power and that the controls needed very little pressure/manipulation to maneuver the airplane. He recalled that any pitch movements or power changes needed to immediately be compensated with rudder adjustments due to the drastic change in yaw. He remembered that the pilot wanted to add strakes or a fin on the airplane to help with the controllability. He further stated that the pilot was unfamiliar with the panel, which made the airplane even more challenging.

According to a Lancair IV-TP expert with many hours of flight experience in various models/configurations of the airplane, the governor was originally designed for blade lengths between 99 to 106 inches. Due to the accident airplane's shorter propeller blade length of 84 inches, the pilot could easily encounter an overspeed condition. Therefore when accelerating for takeoff, it was crucial for the pilot not to advance the engine power too quickly, so as to allow the governor enough time to make the required propeller pitch changes without over speeding the propeller.

The expert additionally stated that around the time of the accident, he tested a new propeller governor for an Avia Propeller (not the same governor as the accident airplane). On the first flight, the propeller's beta light illuminated during takeoff (even though it was not in beta), and the engine was limited when the propeller exceeded 1,900 RPM. He quickly realized that the engine was being limited and reduced Np via the propeller lever. He remarked that during this event, the airplane was almost not flyable due to the amount of rudder pedal input needed during the frequent changes in power resulting from the limiter's effect on the engine.

A former Lancair engineer and general manager was interviewed with regards to the Lancair IV-TP handling characteristics; the complete interview is contained in the public docket for this accident. He stated in the circumstance of a sudden power reduction in the Lancair IV-TP, the airspeed will rapidly decay, and the pilot must push the nose down to maintain flying speed. He noted that following a loss of power, the nose would remain in a nose-up attitude, and unless the pilot made corrective pitch inputs (reducing the angle of attack) within about 4 to 5 seconds, the airplane would become unrecoverable. He added that the airplane would

rapidly reach a critical angle of attack and stall while simultaneously rapidly dropping a wing (the wing that would drop would depend on the particular airplane and how it was constructed). If the airplane stalled in such manner at traffic pattern altitude, there would be no possibility of a pilot recovering. According to the former employee, the departure from controlled flight and the abrupt wing drop are the characteristics that would make the situation unrecoverable.

The former employee added that in the scenario of a sudden power reduction during takeoff due to FCU malfunction, there would be no time for the pilot to adjust the propeller to coarse pitch, use the ISOL valve, and then use the condition lever as the throttle control. If the pilot does not immediately pitch the nose in a 4 to 5 second timeframe, the airplane will stall. By the time the pilot identifies that there is an engine problem and configures the levers accordingly, there would be no time to recover the airplane. He advises that pilots use a go/no-go decision altitude of 1,500 ft agl, where, regardless of the situation, they will land straight ahead in the event of an engine failure if under that altitude. He clarified that if the engine torque reduces to idle during takeoff, there is no possibility of turning back to the runway until at least 1,500 ft agl. This is because of the airplane's heavy wing loading, and its glide ratio of about 7:1 at a fine propeller pitch and 18:1 at full feather (where the best glide speed is about 120 kts indicated).

The former employee opined that the accident airplane's stall speed (in the accident configuration) would likely have been in excess of 80 kts indicated. He estimated that the airplane's approach speed would have been about 110-120 kts indicated.

The former employee further stated that a pilot cannot use full engine power during takeoff on the ground, because the IV-TP was not designed for such a high-horsepower engine and does not have enough rudder authority to compensate for the p-factor at full power, and will consequently depart off the left side of the runway. He noted that having fuel in the baggage area (the aft fuel tank) greatly affects the airplane's center of gravity, and the airplane will be extremely sensitive in pitch.

According to a Lancair IV-TP expert, he had performed a variety of tests in the airplane which included stalling in a variety of scenarios, configurations, altitudes and power settings. He stalled the airplane from 31,000 to 15,000 feet incrementally with 1-4 G's of loading. After hundreds of stalls and over 1,500 hours testing in the Lancair IV-TP he offered the following remarks.

He stated that the airplane will stall and the nose will drop about 15-degrees and with symmetrical wings, will remain straight ahead. A wing can drop left or right depending on slight induced yaw. For the straight ahead stall and subsequent recovery it is critical to keep the ball centered or the wing will drop. It is very sensitive to a ball slightly out of center. During recovery it is very responsive to lowering the nose and reducing the angle attack above all else. The recovery is immediate with a reduction in angle of attack. Never is power applied until 20 percent above the indicated stall speed. If power is on during the stall entry he will reduce to idle immediately upon stall onset.

1.3 METEOROLOGICAL INFORMATION

A routine aviation weather report (METAR) for Boise was issued at 0853. It stated: skies clear; visibility 10 statute miles; wind from 110-degrees at 5 knots; temperature 28 degrees Fahrenheit; dew point 19 degrees Fahrenheit; and altimeter 30.14 inHg.

1.4 WRECKAGE AND IMPACT INFORMATION

The wreckage was located at an estimated 43 degrees 33 minutes 45 seconds north latitude and 116 degrees 12 minutes 57 seconds west longitude, and at an elevation of about 2,860 feet msl. The accident site was in the grassy median just north of a paved service road that runs between parallel runways 10L-28R and 10R-28L and between taxiways D and C. The wreckage was about 1.25 nm from the beginning of runway 10R and about 0.4 nm from the end of the runway.

Past the end of the runway, there lies about 0.8 nm of flat, unpopulated hard- dirt surface. Beyond that lies a sand-gravel pit and several buildings, with flat terrain between. To the north (left) of the runway heading, the interstate was oriented northwest-southwest and crossed the extended runway centerline about 2 nm from the end of the runway. On a bearing of about 175-degrees and 1 nm away was a 1 nm- long closed runway; flat terrain extended in that direction for 3 nm.

The first identified point of impact consisted of a crater in the soft terrain where a propeller blade was imbedded; small pieces of airframe and debris surrounded the disrupted dirt. Numerous portions of the airframe were located in the debris field leading from the initial impact to the main wreckage, the largest of which was a majority of the right wing. The main wreckage was located in an upright position about 80 ft from the initial impact point on a magnetic heading of 046 degrees. The main wreckage had sustained thermal damage and consisted of the engine, inboard portion of the left wing, and fuselage (from firewall to aft baggage area).

Pictures and diagrams of the wreckage location and surrounding terrain are contained in the public docket for this accident.

1.5 MEDICAL AND PATHOLOGICAL INFORMATION

The Ada County Coroner's Office, Boise, Idaho, completed an autopsy on the pilot. The FAA Forensic Toxicology Research Team at the Civil Aviation Medical Institute (CAMI) performed toxicological testing of specimens collected during the autopsy. The results of the testing were negative for carbon monoxide, cyanide, and listed drugs.

1.6 TEST AND RESEARCH

The complete examination reports are contained in the public docket for this accident.

1.6.1 Airframe Examination

The cowling was separated at the firewall and showed no evidence of fire damage. The top section remained intact, and both sides were affixed to portions of the bottom section. The lower area of the bottom section was not present although numerous sections of skin (around 1 foot by 1 foot) were identified as being part of that section due to distinguishing features (e.g., vent slots, intake curvature, etc.). The inside skin contained a loose dirt covering in areas, but there was no oil, soot, or discoloration noted.

The firewall and engine mounting brackets had sustained crush damage and were thermally deformed. The nose wheel over-center links were crushed forward and upward toward the engine (hyper-extended), consistent with the landing gear being down during the accident sequence since the gear was crushed in the opposite direction of the normal aft retraction movement.

The cockpit area had sustained severe thermal damage. The avionics were charred, with wire

bundles exposed and partially melted. The front seat frames were partially attached to the wing spar and the floor section was mostly consumed by fire. The throttle lever was in the idle position with the gate locked. The propeller lever was full forward. The condition lever was in the full forward position.

There was no evidence of pre impact mechanical malfunction or failure with the flight control systems.

The electric fuel pumps were consumed by fire. The pressure header tank remained attached to the engine mount structure. After removal, pressurized air was forced through the center tube while blocking the outlet tubing, and no leaks were detected. The header tank was then cut open to reveal the welded tube in the center; there was no evidence of any anomalies. The screen on the return line was clean.

1.6.2 Engine Examination

A complete teardown inspection was performed on the engine. An external examination revealed that the blow-off valve was in a fully open position, which was an indication that the turbine was below 75 percent N1. The FCU first and second stage elements had sustained impact damage precluding investigators from observing if air was in the system.

The mechanical fuel pump was removed and disassembled revealing that its shaft was intact and bent from impact. The pump's supply line was severed, and the screen filter on the pump contained small dirt particles which were consistent in appearance with fire retardant entering the pump following the initial impact. There was no evidence of excessive wear or pre impact damage.

A borescope inspection of the fuel slinger, inner combustion chamber, outer combustion chamber, compressor turbine nozzle, compressor turbine and power turbine revealed no evidence of catastrophic malfunction or failure. The borescope inspection of the first stage compressor revealed that it contained a layer of soot consistent with post -accident fire. The compressor could not be turned due to the impact damage of the case which lead to the blades making contact with the stators. No evidence of failure or blade damage was found.

The main oil filter was removed and found free of debris. Removal of the 205 bearing filter revealed several small carbon particles that, according to a Lancair expert, were a sign of normal operation. There was no metal found in the oil filters. The front magnetic chip detector contained a fine metal sludge, which according to a Lancair expert was also normal for this detector. The rear chip detector contained one fine metal splinter, and the filter was clean. Both screen filters from the front gearbox were removed and contained no metal particles.

Visual inspection of the propeller revealed that the feathering fly weights were forward in the fine pitch position. The spinner had sustained aft crush damage and was wedged against the fly weights. Two blades remained secured in their hubs, and the third blade had broken free and was found in the initial impact point at the beginning of the debris field. The beta block on the propeller governor was attached and not damaged. The propeller governor linkage position was in the full fine pitch position (take off position).

Disassembly of the engine revealed that the power turbine guide vane was intact, and there did not appear to be contact with the power turbine blades. The nozzle guide vane shroud showed light non-rotational rub marks on the surrounding case, consistent with case ride; there was no curling or indication of rub of the blade tip knife seals from the power turbine blades.

The number two bearing, bearing housing, and rear shaft were intact and showed a dark coloration, which experts stated was consistent with normal operation. Further disassembly revealed that the compressor turbine (also referred to as the gas generator turbine) blades were intact. There were no rub marks on the shroud that surrounded the blades.

The compressor turbine guide vanes leading edges, concave surfaces and inner band all were clean of debris or metal splatter. The compressor turbine guide vane was intact. The inner combustion chamber liner shell was an orangish coloration which experts state was similar in color to when it is manufactured (from ceramic coating); its bracket was similar in color, in indication that it did not come into contact with the slinger ring (attached to the compressor shaft).

The accessory gearbox was removed. The aft face of the inlet air housing was intact and the vanes contained a film of dirt/debris. The first stage compressor blades were intact. The second stage compressor blades showed evidence of light rub with the slight curling of several blades at the trailing edge tips in the opposite direction of rotation (clockwise). The number one bearing was clean and intact; its outer race showed signatures no real rotational signatures. The impeller vanes were intact with no evidence of rub and were black in coloration. There were no obvious rub marks on the respective stators and casing.

The examination revealed no evidence of pre impact mechanical malfunction or failure that would have precluded normal operation.

1.6.3 Fuel Control Unit

The FCU was removed, and the input shaft appeared to be intact. The shaft could be rotated by hand and there was no binding. The condition lever and power lever on the FCU were bent and their positions at the time of impact could not be determined. The power linkage position of the beta and reverse thrust slide indicated that the throttle was about 1/3 forward into the power position, which according to a Lancair expert, would be about 15 degrees on the FCU indicator and around 70 percent N1. A complete teardown inspection of the FCU was conducted and the complete examination report is contained in the public docket for this accident.

The cap to the governor cavity was removed, and the spring and flapper valve were noted to be a red/brown coloration, indicative of corrosion. The speeder spring was removed, and the fly weights appeared to be closed inward, which is the position at rest and also consistent of an under-speed condition. The entire accessory gear box spline shaft was removed, revealing that the balls were corroded and frozen in place. Examination of the gear teeth and shaft revealed no evidence of wear or failure. The area between the flapper valve and the delta p diaphragm was clean; the rubber was pliable. The main metering valve was removed with no anomalies noted.

The accelerator cavity contained a liquid consistent in odor and appearance to that of jet fuel. The altitude compensation cavity contained trace amounts of red/brown coloration, consistent with corrosion. The fuel screen (last chance filter) from the overflow fuel valve to the altitude compensation cavity was clean and free of debris. The teeter valve located between the screen and the bellows was a red/brown coloration. The electro-hydro transducer was removed with no anomalies noted.

The emergency throttle lever (engine shutoff) was removed, and the spline teeth were geared on the emergency throttle valve. The emergency metering valve pressure regulator was in the

closed position and took force to remove (normally a loose fit). There was a hard black substance on the piston that was located near the center. The emergency solenoid was removed and found in the non-activated position (which is the at rest position when no electricity is applied to the circuit).

The FCU had red/brown coloration in numerous areas, consistent with numerous areas being corroded. A fuel sample from the main metering valve orifice was tested, in an effort to detect if any water was present in the sample; no water was present, which is consistent with exposure to fire retardant following the initial impact.

The main metering valve had areas of corrosion that aligned with it being in the closed position, which correlated with ground idle. The emergency control lever and corresponding valve were in the open position (over the 40-degree detent). The lack of corrosion in the acceleration cavity was consistent with no increase in power (or necessity for the acceleration circuit when the FCU was functioning). The areas with the most pervasive areas of corrosion were the governor and the main metering valve cavity, which were interconnected via a large orifice and the corrosion signatures were consistent with fire suppression fluid entering the FCU after impact.

Numerous parts could not be examined due to the condition of the unit (corroded) precluding their removal. The examination revealed no evidence of pre impact mechanical malfunction or failure that would have precluded normal operation.

1.7 ADDITIONAL INFORMATION

1.7.0 Lancair

Lancair International, Inc. is based in Redmond, Oregon and founded in 1984. The Lancair fleet includes a wide range of aircraft from early 235, 320 and 360 two-seat models to the two-seat Lancair Legacy, fixed-gear Lancair ES, the IV, the pressurized IV-P, the turbine IV-TP, and the latest model, the Evolution. Over 2,000 Lancair kits have been sold in more than 34 countries.

The Lancair IV was a progression from the Lancair 235 and the 320. The kit manufacturer wanted to build a four-place retractable landing-gear airplane that had competitive performance to that of certified aircraft. According to Lancair, the IV is essentially a scaled-up version of the 320 with a 30-ft. wingspan and a turbo-charged 350-hp reciprocating engine equipped with a three-blade constant-speed propeller. Since its introduction in 1990, the Lancair IV has broken numerous speed and altitude records for its class type and at altitude has reached sustained speeds in excess of 340 mph (with no tailwind). The entire airframe is constructed of vacuum-formed, oven-cured, prepreg carbon fiber. The company estimates a build time of approximately 2,500 hours.

The former Lancair engineer stated that he worked for the company from March 2002 to April 2009 as a General and Engineering manager, with his last project consisting of helping in the design of the Evolution. He stated that the Lancair IV was originally designed for a reciprocating Teledyne Continental Motors (TCM) engine (a turbocharged and non-turbo charged model) with a gross weight of about 3,200 pounds (with an empty weight of 1,800-1,900 pounds). Thereafter, with the desire to increase performance, Lancair designed the airplane to be fitted with a TCM turbocharged and modified and pressurized the airframe, resulting in the Lancair IV-P. The addition of the structural enhancements to the wing increased the gross weight to about 3,550 lbs.

In 2001, Lancair selected the Walter/General Electric 601E as the test trial turboprop engine to design/retrofit the airframe for higher performance. As part of this design modification, the airframe structure underwent several significant changes including: the nose became about 13 inches longer (more with the inclusion of the propeller and spinner), and the fuel tank located in the belly increased from 9.5 gals to 35 gals. With the heavier airframe structure and engine/equipment, the gross weight increased.

The engineer further stated that other aerodynamic changes occurred during this modification. Specifically, with the increase of nose length, the airplane's pitch and yaw axes were destabilized, and with the larger diameter propeller (that had greater inertia), the three axes were destabilized further. In effect, these changes resulted in the nose section becoming a destabilizing "flying nose," that, in response to an increase in pitch, would produce lift, generating an additional nose-up pitching moment. With the airplane's increased empty weight, the wing loading increased dramatically, which he estimated at upward of 40-45 pounds per square foot. With the laminar flow wing design of the airplane and the already-existing aggressive stall characteristics, the stall characteristics were aggravated further which makes the Lancair IV-TP a challenging airplane to fly, which without adequate training, makes it a dangerous airplane because it was not designed for such a high horsepower engine.

1.7.1 Lancair Fleet and Accident Rate

The following breakdown was provided by the Lancair Owners and Builders Organization (LOBO) and gives the best estimate of the accident rate for the Lancair fleet (see figure 03 in the public docket for the graph):

Lancair Model : Flying, Accidents, %Accidents, Fatal, %Fatal Accidents

Lancair 200/235 103 32 31% 16 50%

Lancair 320/360 301 76 25% 28 37%

Lancair ES 96 4 4% 3 75%

Lancair IV/IV-P 240 51 21% 27 53%

Lancair IV-TP 57 15 26% 11 73%

Legacy 121 27 22% 14 52%

Lancair Evolution 50 2 1% 0 0

Totals 922 207 22% 99 9%

The figure shows that at the time of this report, of the 57 Lancair IV-TPs that were registered (and presumably flying), there is an accident rate of 26-percent and a fatal accident rate of 19-percent.

1.7.2 FAA and Lancair

The FAA convened two safety groups specifically to address the Lancair's "unusually high accident and fatality rate compared to other amateur-built aircraft." The purpose of each group was to "bring the issue to attention of the FAA so appropriate action may be taken." These internal FAA groups were initiated by the Office of Accident Investigation and Prevention (AVP)-100 and were conducted over the course of a six-month period in both 2008 and 2012-

2013. The end conclusion of the studies determined that the FAA has the ability and, given the safety findings that surfaced over the studies, "the responsibility to expose its findings and take the appropriate safety enhancement actions it believes would reduce the likelihood of certain Lancair accidents."

According to copies of the notes from the studies, there were internal FAA concerns that any agency requirement imposed upon Lancair would be analogous to the FAA becoming involved in experimental aircraft design certification or in some way intruding in an area for which it had no authority. There was also concern that taking action on Lancair would create a precedent throughout the amateur-built aircraft industry and that the FAA would then be forced to take action on every safety issue affecting an amateur-built aircraft. There were limitations concerning the FAA's role which was centered on the general airworthiness inspection when the aircraft is submitted for airworthiness certification (unless there is specific safety data available).

The FAA did note in response to these concerns that they indeed have the "statutory and regulatory responsibility to issue airworthiness certificates to amateur-built aircraft and the existing guidance [FAA Order 8130.2F, Section 153 (a)] on this process specifically permits the FAA to impose operating limitations deemed necessary in the interest of safety." As of this publishing of this report, the current guidance is FAA Order 8130.2G, Chapter 4, Section 9, Paragraph 4104 (a), since FAA Order 8130.2F was cancelled April 16, 2011. Further, the authority of the FAA is flexible and imposing limitations is authorized in 49 USC 4704 (d)(1), which provides that "the Administrator may include in an airworthiness certificate terms required in interest of safety."

In specific reference to the Lancair IV-TP, the FAA remarked that certified and experimental aircraft with similar high-performance characteristics require specific training. On numerous occasions (e.g., Viperjet, Robinson Helicopters, Mitsubishi MU-2), the FAA has made type-specific safety determinations when finding that the safe operation of such aircraft requires specific training, proficiency and/or equipment. It was noted in both the studies that many of the Lancairs would be classified as Technically Advanced Aircraft (TAA), with an EFIS-equipped cockpit.

These conclusions were derived based on accident statistics of a sample between 2004 and 2008 that disclosed amateur-built aircraft experienced a fatal accident rate of about 5-6 accidents per 100,000 flight hours; the overall general aviation accident rate for that period was about 1-2 accidents per 100,000 hours. Lancairs' fatal accident rate in the same time period was about 7-8 accidents per 100,000 flight hours. Specifically, in 2008 Lancair comprised 3.2-percent of the amateur-built aircraft fleet and 19-percent of the fatal accidents that occurred that year, with 78.6-percent of Lancair accidents being fatal.

The study noted that based on the statistics, Lancairs are involved in fatal accidents at "a rate that is disproportionate to their fleet size."

The study found that with extensive use of laminar flow airfoils, low thickness, low surface velocities, gradual velocity changes and low skin friction, Lancairs' stall characteristics are critical (abrupt, unusual) when compared with more traditional certified aircraft. In character, "the stall occurs abruptly, even during a slow deceleration just above 70 kts with a 20-degree pitch break and a wing drop as much as 50 degrees."

As part of its 2008 safety review, the FAA remarked that there were "strong indications" that

Lancair would be receptive to FAA directives that would result in incorporation of type-specific training and stall warning devices as part of its kit sales.

As a result of the Lancair Task Force, recommendations were made to FAA management in November 2008. The recommendations included: publishing an article in FAA Aviation News, issuing a SAIB with regards to flight training and equipment recommendations on applicable models, drafting an InFO based on the SAIB, revising the language for the passenger warning placard applicable to amateur-built aircraft, initiating informal resolution in coordination with industry, and tracking accident data regularly in order to identify any changes in the Lancair accident trends.

The FAA issued InFO notice 09015 on September 25, 2009, with the subject of "Safety Concerns of Lancair Amateur-Built Experimental Airplanes." The notice indicated that while Lancairs represented a little over 3-perecnt of the amateur-built experimental aircraft fleet, they contributed to 16-percent of all amateur-built fatal aircraft accidents in the prior 11 months, of which 65-percent of those were fatalities. In the four years prior, 53-percent of Lancair accidents were fatal, and a majority were a result of the pilot experiencing a loss of control of the airplane while in the traffic pattern. The notice further stated that pilots must take the following corrective actions for safe operation:

-review and thoroughly understand all information regarding stall characteristics and obtain specialized training regarding slow flight handling characteristics, stall recognition, and stall recovery techniques.

-install a high-quality angle of attack indicator to provide a warning of impending stall.

-have their airplane evaluated by an experienced Lancair mechanic to ensure proper rigging, wing alignment, and weight and balance.

The notice was recalled shortly after its release; this is the only InFO notice that has ever been recalled. Although the original InFO (InFO 09015) was supported by LOBO, Lancair contested that they were not the only manufacturer to have a high-performance amateur-built airplane. As a result, InFo 09015 was retracted and InFO 10001 was issued March 09, 2010, which expanded the InFO to include other aircraft with the same characteristics and covered "amateur-built experimental Lancair and other amateur built airplanes possessing high wing loading and stall speeds in excess of 61 knots."

1.7.3 Lancair Training

According to LOBO, experimental aircraft, almost by definition, are often equipped with novel systems and configurations that are not available in certified aircraft. Depending on the complexity of the systems installed, pilots likely will require orientation and specially-tailored training to operate them safely. With the Lancair, many of the airplanes are equipped with EFISs, autopilots, multiple radios and support systems that, although they can provide tremendous capabilities, significantly add to operational complexity. When transitioning into a Lancair, most pilots simultaneously have the task of learning new complex avionics and the handling characteristics of the high performance airplane, with operating manuals that vary widely in accuracy and completeness.

There are three sources of Lancair training that most insurance companies accept as a prerequisite for coverage. The LOBO has a FAA Industry Training Standards (FITS)-accepted training syllabus and provides CFIs that have completed qualification training in specific

models of Lancair aircraft and that are located throughout the US. High Performance Aircraft Training (HPAT) provides training in customer-owned aircraft at designated US locations on an annual schedule. Elite Pilot Services additionally provides training specializing in the Evolution.

The training both sources offer emphasize demonstrations of the feelings and visual observations associated with the airplane's unique handling characteristics. This includes the difference in the glide ratio with coarse and fine pitch propeller settings, the nuances of entering the traffic pattern and maneuvering at a higher altitude (1,500 ft agl vs the normal 1,000 ft agl) to allow ample time to make a stabilized approach, the lag in engine response when adding full power, how to perform a power-off landing, and execution of a go-around (not using full power).

1.7.4 Experimental "Second Owners"

A "second owner" is a purchaser of an experimental aircraft that was not involved in its construction/build and registration/certification process. There is an inherent difficulty in reaching and influencing second owners before they start flying their newly purchased aircraft due to a delay in the title transfer being published (the only way for the public to be made aware of a new owner). First owners normally have years learning about their aircraft during the building process, including critical subjects such as any unique handling or operating characteristics of the aircraft they are building. More importantly, the experience/knowledge required to complete such a project makes it much more likely the original builder has sought the following: information about FAA and industry standards, the assistance of the kit manufacturer, and interaction with aircraft type/model clubs. In contrast, second owners have access to a fully functional aircraft almost immediately after making their purchase.

1.7.5 Lancair Community

The LOBO conducted a survey of its members concerning mandatory Lancair training during February 2012. A total of 126 complete surveys were returned for analysis. Of the 126 respondents, 97 percent were Lancair aircraft owners and 69 percent were the builder of record for their aircraft. The results showed a majority supported mandatory training in regards to the potential for lower accident rates and lower insurance premiums. Eighty-one percent agreed or strongly agreed in supporting mandatory training that could lower the accident rate, while seventy-seven percent agreed or strongly agreed in supporting mandatory training if it could lower insurance premiums.

History of Flight

Initial climb	Aerodynamic stall/spin (Defining event)

Pilot Information

Certificate:	Airline Transport	**Age:**	51
Airplane Rating(s):	Multi-engine Land; Multi-engine Sea; Single-engine Land; Single-engine Sea	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 Without Waivers/Limitations	**Last Medical Exam:**	01/01/2011
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:	3600 hours (Total, all aircraft), 13 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	GARZA	**Registration:**	N321LC
Model/Series:	LANCAIR IV-TP	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	Yes
Airworthiness Certificate:	Experimental	**Serial Number:**	003
Landing Gear Type:	Retractable - Tricycle	**Seats:**	4
Date/Type of Last Inspection:	04/11/2011, Annual	**Certified Max Gross Wt.:**	
Time Since Last Inspection:	48 Hours	**Engines:**	1 Turbo Prop
Airframe Total Time:	339 Hours	**Engine Manufacturer:**	Diemech Turbine
ELT:	Installed, not activated	**Engine Model/Series:**	M601D
Registered Owner:	Steven Appleton	**Rated Power:**	
Operator:	On file	**Air Carrier Operating Certificate:**	None

Meteorological Information and Flight Plan

Observation Facility, Elevation:	BOI, 2871 ft msl	**Observation Time:**	0853 MST
Distance from Accident Site:		**Condition of Light:**	Day
Direction from Accident Site:		**Conditions at Accident Site:**	Visual Conditions
Lowest Cloud Condition:	Clear	**Temperature/Dew Point:**	-2°C / -7°C
Lowest Ceiling:	None	**Visibility**	10 Miles
Wind Speed/Gusts, Direction:	7 knots, 130°	**Visibility (RVR):**	
Altimeter Setting:	30.14 inches Hg	**Visibility (RVV):**	
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Boise, ID (BOI)	**Type of Flight Plan Filed:**	None
Destination:	Boise, ID (BOI)	**Type of Clearance:**	VFR
Departure Time:	0855 MST	**Type of Airspace:**	

Airport Information

Airport:	Gowen Field (BOI)	**Runway Surface Type:**	Asphalt
Airport Elevation:	2871 ft	**Runway Surface Condition:**	Dry
Runway Used:	10R	**IFR Approach:**	None
Runway Length/Width:	9763 ft / 150 ft	**VFR Approach/Landing:**	Forced Landing; Traffic Pattern

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	N/A	**Aircraft Fire:**	On-Ground
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal		

Administrative Information

Investigator In Charge (IIC):	Zoe Keliher	**Adopted Date:**	09/08/2014
Additional Participating Persons:	Christine Soucy; Federal Aviation Administration; Washington D.C, DC Tom Bowen; Lancair International Inc.; Redmond, OR		
Publish Date:	09/08/2014		
Investigation Docket:	http://dms.ntsb.gov/pubdms/search/dockList.cfm?mKey=82809		

The National Transportation Safety Board (NTSB), established in 1967, is an independent federal agency mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

The Independent Safety Board Act, as codified at 49 U.S.C. Section 1154(b), precludes the admission into evidence or use of any part of an NTSB report related to an incident or accident in a civil action for damages resulting from a matter mentioned in the report.