



National Transportation Safety Board Aviation Accident Final Report

Location:	Sisters, OR	Accident Number:	WPR13LA396
Date & Time:	09/01/2013, 1800 PDT	Registration:	N102HA
Aircraft:	FLIGHT DESIGN GMBH CTSW	Aircraft Damage:	Substantial
Defining Event:	Fuel exhaustion	Injuries:	1 None
Flight Conducted Under:	Part 91: General Aviation - Personal		

Analysis

The sport pilot was conducting a cross-country flight in the light-sport airplane, and he reported that he encountered strong headwinds during the flight. Concerned that the airplane's fuel level may be low, he landed at a private airstrip a few miles before his intended destination. He checked the fuel levels and estimated that there was enough fuel for about 30 minutes of flight. He chose to depart, and a few minutes after takeoff, the engine lost all power. He performed a forced landing into a field just short of the destination airport. The airplane sustained substantial damage during the accident sequence, and the pilot was not injured. Immediately following the accident, the pilot reported that the airplane did not have any mechanical malfunctions and that it ran out of fuel. Postaccident examination did not reveal any evidence of a preimpact engine malfunction or failure. Both fuel tanks were found intact and did not appear to be breached. The airplane's fuel system appeared to meet the light-sport airplane industry design standards for usable fuel, which are similar to the Federal Aviation Administration standards for certified aircraft.

The pilot did not respond directly to multiple requests from the National Transportation Safety Board investigator-in-charge to answer questions regarding the specific accident circumstances. Therefore, the accident conditions could not be fully established. However, the pilot did provide multiple written declarations regarding the quantity of fuel on board at the time of departure from the private airstrip; these reports stated that between 3 and 4.5 gallons of fuel were in the right tank and that no fuel was in the left tank. However, only 1 gallon of fuel was recovered from the right wing tank, and the left tank was found empty, which was well below the Federal Aviation Regulations (FARs) minimum fuel requirements for flight, which state that "no person may begin a flight under visual flight rules conditions unless there is enough fuel to fly to the first point of intended landing and...to fly after that for at least 30 minutes of flight." Regardless of the pilot's written estimates of the fuel onboard, as noted previously, in his initial statement, he indicated that the airplane only had about enough fuel remaining for 30 minutes of flight, which was still not enough fuel to meet the FARs minimum fuel requirements, and, therefore, his decision to take off at that time was improper.

The design of the airplane's wing resulted in both the fuel sight gauge and the dipstick being

prone to significantly misrepresenting the actual fuel quantity when the airplane was not level. Therefore, it is possible that the pilot misinterpreted the actual fuel quantity before takeoff. In addition, he exhibited poor decision-making by failing to land earlier in the flight for fuel even though he overflew at least four airports that had fueling facilities. The pilot appeared to have accrued almost 300 hours of flight experience in the airplane since he purchased it about 2 1/2 years earlier. Therefore, he should have had adequate knowledge about its systems and performance capabilities and known that the dipstick and sight gauge were prone to errors and that the airplane would need more fuel to complete the flight.

A similar accident in the United Kingdom (UK) resulted in the airplane's UK type certificate holder issuing a service bulletin (SB) that recommended that both sight gauges show fuel in flight and that a landing be performed if any gauge reads empty. The SB also warned that, with one tank empty, the flight can continue provided no turbulence is encountered and the airplane is not flown in a sideslip condition such that fuel moves away from the tank outlet. The airplane's US distributor has not issued an SB regarding flight with one fuel tank empty, and this issue is not addressed in any placards or aircraft operation manuals; therefore, it is possible that the pilot did not realize the limitations of flying the airplane with one fuel tank empty.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The pilot's inadequate preflight fuel planning and poor decision-making, which resulted in fuel exhaustion and the subsequent loss of engine power. Contributing to the accident was the lack of documentation describing the limitations of the airplane's fuel system.

Findings

Aircraft	Fuel - Fluid level (Cause)
Personnel issues	Fuel planning - Pilot (Cause) Decision making/judgment - Pilot (Cause)
Organizational issues	Design of document/info - Manufacturer

Factual Information

HISTORY OF FLIGHT

On September 1, 2013, about 1800 Pacific daylight time, a Flight Design CTSW, N102HA, lost engine power and landed about 1/2 mile short of its intended destination, Sisters Eagle Air Airport, Sisters, Oregon. The light sport airplane was registered to, and operated by, the pilot under the provisions of 14 Code of Federal Regulations (CFR) Part 91. The airplane sustained substantial damage during the accident sequence, and the sport pilot was not injured. The personal flight departed Whippet Field Airport, Sisters, at an unknown time. Visual meteorological conditions prevailed, and no flight plan had been filed.

The pilot provided a verbal statement to a deputy of the Deschutes County Sheriff's Office following the accident. He reported that earlier in the day he departed from Coeur d'Alene, Idaho, en route to Sacramento, California, and that he encountered strong headwinds and low clouds during the flight. Subsequently he landed at Whippet Field, a private dirt airstrip approximately 5 miles east of Sisters Eagle Air Airport to check the airplane's fuel levels. Estimating that he had sufficient fuel for approximately 30 more minutes of flight, he departed. As he approached Sisters Eagle Airport the engine "sputtered" and then stopped producing power. He stated that the engine then started again, but then stopped. The airplane then struck soft dirt, and according to the pilot, it did not crash, but encountered an, "Off runway landing." He stated that the airplane did not have any mechanical problems, and that it ran out of fuel. He further reported that he was renting the airplane, that it was owned by "World Adventure Series," and that the purpose of the flight was to transport a dog to its new owner in California. In a subsequent correspondence with the NTSB investigator-in-charge (IIC) he listed himself as the airplane's owner.

Subsequent examination revealed that the airplane had sustained substantial damage to the firewall, forward cabin structure, and lower right fuselage.

The pilot did not submit a Pilot/Operator Aircraft Accident Report (NTSB Form 6120.1), or respond to multiple requests from the IIC for a phone interview.

In a subsequent correspondence, the pilot's attorney stated that during the flight the pilot encountered strong westerly headwinds, and was having trouble with bright sun in his eyes, and as a result he experienced difficulty reading the instruments, especially the fuel gauge.

The NTSB IIC requested via email that the pilot answer a series of questions further explaining the accident circumstances. His attorney responded, stating that the pilot had elected to deny the request, asking instead to refer to the circumstances described in the complaint the pilot had filed for damages against Flight Design USA, et al, in the U.S. District Court.

PERSONNEL INFORMATION

The pilot held a sport pilot certificate; as such he was limited to flying during the hours of daylight. The certificate was issued on November 27, 2011.

AIRPLANE INFORMATION

The airplane was manufactured in 2007 by Flight Design GmbH, and imported into the United States that year. The pilot purchased the airplane from Flight Design in August 2010, and then transferred ownership to the current owner (a trust located at his home address) in April 2011.

According to documentation provided by Flight Design, up until the pilot purchased the airplane in 2010, it had been a demonstration airplane and had accrued a total flight time of about 88 hours. The Hobbs hour meter indicated 382.9 hours at the accident site.

The airplane was powered by a Rotax 912ULS series engine, equipped with a Neuform 2-blade composite propeller. The airplane was equipped with a BRS Aerospace emergency parachute recovery system, which had not been activated during the accident. The most recent documented inspection occurred on November 10, 2012, and was for a condition inspection. At that time, both the airframe and engine had accrued a total flight time of 348.9 hours.

METEOROLOGICAL INFORMATION

Aviation weather observation stations positioned along the route of flight reported similar weather conditions consisting of clear skies, visibility of 10 miles or greater, and light winds.

The closest National Weather Service weather observation to the accident site was from Roberts Field Airport, Redmond, Oregon, located approximately 17 miles east of the accident site at an elevation of 3,080 feet. The airport had an Automated Surface Observation System, which at 1756 reported wind from 330 degrees at 6 knots, clear skies, and visibility of 10 miles. The next observation at 1856 indicated clear skies but with wind from 310 degrees at 11 knots gusting to 18.

The NWS had no advisories current for the route for any Instrument Flight Rules or mountain obscuration conditions, thunderstorms, icing, or any significant turbulence at the time of any preflight weather briefing prior to departure.

The winds aloft forecast for the region indicated winds at 6,000 feet out of the west-southwest with velocities between 9 and 16 knots. At 9,000 feet, the winds were generally out of the southwest, with velocities of between 12 and 31 knots.

According to the U.S. Naval Observatory, Astronomical Applications Department, the computed sunset occurred in Redmond, at 1940, with civil twilight ending at 2010. At 1810, the sun was 15.6 degrees above the horizon at an azimuth of 265 degrees.

TESTS AND RESEARCH

Both wings were removed from the airplane, which was then recovered from the accident site, and examined on February 4, 2014, by the NTSB IIC, and representatives from the FAA, Rotax Aircraft Engines, and Flight Design USA. As the state of manufacture, the German Federal Bureau of Aircraft Accident Investigations (BFU) assigned a non-traveling accredited representative.

The fuel system was examined and was found to be free of obstructions. Both fuel tanks were intact and did not appear to be breached. The fuel caps were in place, and both cap gaskets were intact and pliable, with the cap vents facing the correct direction. The fuel tanks were inspected internally and no debris, contamination, or de-bonding was observed.

Examination of photographs taken at the accident site revealed a circular area of dust surrounding the right wing filler cap, along with a fluid-like streak of dust emanating from the fuel cap and moving aft. Remnants of these signatures were still present during the examination. The photos indicated that the airplane came to rest right-wing-low due to the collapse of the right main landing gear during the impact sequence. The direction of the fuel stain signatures were consistent with a prior tank overflow event, rather than fuel leaking from

the tank post-accident.

There was no evidence of pre-impact engine malfunction or failure, and following completion of the examination, the engine was started and operated appropriately at various speeds. A complete examination report is contained within the public docket.

Fuel System Design

The CTSW airplane is equipped with two integral wing tanks, each with a capacity of 17 gallons (16.5 useable). The tanks are 57 inches long by 15 inches wide, extending from the wing root, and positioned forward of the main spar. Fuel quantity is gauged visually within the cabin through a sight-tube located at each wing root rib. Both wings have a dihedral angle of 2 degrees, and a rigid pickup tube with an integral strainer is located at the tank floor at each wing root. Each tank contains a single baffle (anti-sloshing rib) located approximately 21 inches from the root. Fuel passes through the baffle via a series of holes at the leading edge, upper spar cap, and when the fuel quantity is low, through a series of 5 and 8 millimeter holes adjacent to the tank floor. The fuel tanks are vented through vented fuel caps located on the upper outboard surface of the wings. A calibrated dipstick with separate left and right tank increments is utilized to check the fuel quantity when on the ground.

Fuel is fed by gravity down two fuel lines in the cabins A-columns; according to the CTSW Maintenance and Inspection Procedures Manual, the lines in the A-columns are of larger volume, "to maintain fuel flow also in sideslip conditions with low fuel for a certain time". The two lines are connected at a T-fitting located on the engine side of the firewall. From the T-fitting, fuel is routed back into the cabin, and through a fuel shutoff valve (on/off only) and fuel filter. The fuel is then routed back through the firewall to the gascolator located adjacent to the lower section of the engine mount, and then onwards to an engine-driven fuel pump.

The design allows fuel to be fed from both tanks simultaneously, and there is no provision for the pilot to make a fuel tank selection.

Fuel System Testing

Both wings were reattached to the fuselage, along with their respective fuel line fittings. The airplane was leveled both laterally and longitudinally and fuel (totaling 3.5 gallons per side), was incrementally added to each tank while simultaneously recording the levels utilizing both the cabin sight gauge, and the Flight Design fuel quantity dipstick found in the airplane.

The dipstick quantity generally matched the tank quantity. The sight gauges, although prone to parallax error, were accurate to within 1 gallon. However, it was noted that small changes of the airplane's bank angle resulted in large fluctuations in the quantity observed at the sight gauge; specifically, with 3.5 gallons of fuel in the tanks, lowering the right wing 2 degrees resulted in the indicated fuel dropping to the 1-gallon level. Similar but reversed (due to the location of the cap at the tip of the tank) values were observed at the dipstick for various bank angles.

Recovered Fuel Quantity

Recovery personnel reported draining about 1.5 gallons from the right wing tank during the recovery, and stated that the left wing tank was empty. They did not observe fuel issue from either of the wing tank fuel lines during removal of the wings from the airframe. When questioned about the method utilized to gauge the recovered fuel quantity, a recovery technician stated that it filled the lower 3 inches of a 5-gallon bucket. The examination group

then filled the same bucket with fuel to the 3-inch level and measured the quantity with a calibrated beaker, resulting in an observed total of 1 gallon and 4 ounces (1.03 gallons).

Fuel Records

Two fueling facilities were located at Coeur d'Alene Airport, and both were capable of supplying 100 low-lead aviation gasoline. Both facilities reviewed their fueling records for the one week period leading up to the accident, and neither could locate records for the pilot or airplane during that period.

Whippet Field Airport was a private field comprised of a single turf airstrip. It did not have provisions for refueling. The airstrip was along the presumed route of flight, and about 5.5 miles east of Sisters Eagle Air Airport.

The last 170 miles of the route of flight (assuming a heading of 230 degrees magnetic) would have passed within 10 miles of 17 airports, 4 of which had refueling facilities.

ADDITIONAL INFORMATION

Pilots Statement Regarding Fuel Quantities

The pilot and his attorney provided three separate submissions containing references to the fuel quantity onboard the airplane when it departed Whippet Field Airport. The first included a statement written by the pilot, and signed presumably by a witness reporting that the witness observed the pilot check the fuel quantity utilizing the fuel gauge dipstick, and that the right fuel tank contained 3 gallons of fuel (a separate notation of "over 3 gallons" was written in a different typeface at the end of the sentence). A second document written by the pilot's attorney stated that 4.5 gallons of fuel was present in the right tank. A subsequent email sent by the pilot stated that the airplane was carrying between 3 to 4 gallons of fuel in the right tank. All documents reported that the left tank was empty.

CTSW Operating instructions

According to the CTSW Airplane Operating Instructions current for the airplane at the time of the accident, the airplane's fuel capacity was 17 US gallons per tank, 16.5 of which is usable. The manual states that fuel is gravity fed, and that the fuel valve has two positions, either "on" or "off".

The engine can operate on both 100 low-lead aviation gasoline as well as premium automotive unleaded gasoline which meets American Society for Testing and Materials (ASTM) D 4814 specifications, with a minimum anti knock index of 91. Fuel consumption at takeoff and "75% continuous performance" was 7.1 and 4.9 gallons per hour, respectively.

Flight Design discontinued production of the CTSW model in 2007, replacing it with a similar variant, the CTLS. The fuel system remained largely the same with the exception that a return flow flapper valve was included on the fuel tank anti-sloshing rib. Additionally the tanks were interconnected with a vent line, and each tank also vented to its respective wingtip. The CTLS Airplane Operating Instructions, Normal Operating Procedures (Cruise) section, denoted of the following:

"Warning: A correct indication on the fuel sight gages in the wing ribs is only possible when the aircraft is leveled.

Warning: There is a tendency to fly the CTLS-LSA with a small sideslip angle. Flight

performance is only marginally affected but it can lead to the tanks emptying at different rates. In this case, it is recommended to raise the wing with the fuller tank in a gentle temporarily slip. This can be achieved with the help of the rudder trim, if installed. The aircraft should be returned to level flight after a few minutes and the fuel indication checked. The amount in the tanks should now be more even.

Warning: The tanks in the CTLS have return flow flapper valves on the fuel tank anti-sloshing rib (refer to Chapter 7 Systems Description). They prevent fuel from quickly flowing into the outer tank area during side slipping where it could not be fed into the engine. The return flow valve reduces but does not completely prevent return flow. An exact indication of fuel quantity is thus only possible at the wing root when, after a sideslip, the aircraft has returned to normal flight attitude (and the amount of fuel inside and outside the anti-sloshing rib has evened out)."

The CTSW flight manual did not contain similar verbiage, and neither the CTLS or CTSW manuals, nor any airplane placards or Flight Design USA safety directives made any recommendation regarding flight with one fuel tank empty.

ASTM Standards

The CTSW airplane was designed to comply with the ASTM Consensus Standards, F2245, Revision 4 (Design and Performance of a Light Sport Airplane). The standards make only one reference with regards to unusable fuel:

"7.3.1. The unusable fuel quantity for each tank must be established by tests and shall not be less than the quantity at which the first evidence of engine fuel starvation occurs under each intended flight operation and maneuver."

By comparison, aircraft certified under 14 CFR Part 23 (Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes) must meet the following standards:

"23.959 (a) Unusable fuel supply. The unusable fuel supply for each tank must be established as not less than that quantity at which the first evidence of malfunctioning occurs under the most adverse fuel feed condition occurring under each intended operation and flight maneuver involving that tank."

CTSW Accident in the United Kingdom

The United Kingdom Department for Transport Air Accidents Investigation Branch (AAIB) investigated an accident on August 12, 2009, involving a similarly equipped CTSW airplane. The airplane experienced a fuel starvation event during the landing approach. It was subsequently determined that at that time, the right tank was empty, and the left tank contained about 1.32 gallons of fuel.

Testing performed during that accident investigation established that with 1.32 gallons of fluid in the right tank, and the wing set to an angle of 8 degrees, the sight gauge indicated that the tank was almost half full. Subsequent tests revealed that with the tank level, it continued to issue fluid at its outlet until only 0.132 gallons remained.

The investigation identified flight planning as a contributory factor and the AAIB issued a recommendation that, "Flight Design GmbH, together with P&M Aviation (the CTSW type certificate holder in the UK), revise their assessment of the unusable fuel in the CTSW aircraft."

P&M Aviation subsequently issued Service Bulletin SB 131. The service bulletin did not make any revisions to the unusable fuel quantity as recommended by the AAIB, but instead recommended a detailed series of actions with regard to monitoring fuel quantities, including the recommendation that both sight gauges must show fuel in flight, and that a landing should be performed if any gauge reads empty. The service bulletin further stated, "if one tank should empty before the other, in level flight the remaining fuel can still be used up....However, if the aircraft is in turbulence and/or the airplane is flown with sideslip putting the outboard end of the feeding tank low, it is possible for the feed to be uncovered and air to be drawn into the system causing the engine to stop."

Fuel Requirements

Federal Aviation Regulation 14 CFR 91.151, under Visual Flight Rules (VFR), "Fuel requirements for flight in VFR conditions" states in part, that no person may begin a flight in an airplane under VFR conditions unless (considering wind and forecast weather conditions) there is enough fuel to fly to the first point of intended landing and, assuming normal cruising speed during the day, to fly after that for at least 30 minutes.

History of Flight

Enroute-cruise	Fuel exhaustion (Defining event) Loss of engine power (total)
Landing	Off-field or emergency landing
Landing-flare/touchdown	Collision with terr/obj (non-CFIT)

Pilot Information

Certificate:	Sport Pilot	Age:	63
Airplane Rating(s):	Single-engine Land	Seat Occupied:	Unknown
Other Aircraft Rating(s):	None	Restraint Used:	
Instrument Rating(s):	None	Second Pilot Present:	No
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Sport Pilot None	Last FAA Medical Exam:	
Occupational Pilot:	No	Last Flight Review or Equivalent:	
Flight Time:	(Estimated) 300 hours (Total, all aircraft), 300 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	FLIGHT DESIGN GMBH	Registration:	N102HA
Model/Series:	CTSW	Aircraft Category:	Airplane
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Special Light-Sport	Serial Number:	07-06-21
Landing Gear Type:	Tricycle	Seats:	2
Date/Type of Last Inspection:	11/10/2012, Condition	Certified Max Gross Wt.:	1320 lbs
Time Since Last Inspection:	34 Hours	Engines:	1 Reciprocating
Airframe Total Time:	382.9 Hours at time of accident	Engine Manufacturer:	ROTAX
ELT:	C91A installed, not activated	Engine Model/Series:	912ULS
Registered Owner:	BERNATH NICOLE OI-EN WONG	Rated Power:	100 hp
Operator:	On file	Operating Certificate(s) Held:	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	Condition of Light:	Day
Observation Facility, Elevation:	RDM, 3080 ft msl	Distance from Accident Site:	17 Nautical Miles
Observation Time:	0056 UTC	Direction from Accident Site:	100°
Lowest Cloud Condition:	Clear	Visibility	10 Miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	6 knots /	Turbulence Type Forecast/Actual:	/
Wind Direction:	330°	Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	29.79 inches Hg	Temperature/Dew Point:	33° C / 2° C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Sisters, OR (OR34)	Type of Flight Plan Filed:	None
Destination:	Sisters, OR (6K5)	Type of Clearance:	None
Departure Time:	1755 PDT	Type of Airspace:	

Airport Information

Airport:	SISTERS EAGLE AIR (6K5)	Runway Surface Type:	N/A
Airport Elevation:	3168 ft	Runway Surface Condition:	Dry
Runway Used:	N/A	IFR Approach:	None
Runway Length/Width:		VFR Approach/Landing:	None

Wreckage and Impact Information

Crew Injuries:	1 None	Aircraft Damage:	Substantial
Passenger Injuries:	N/A	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	1 None	Latitude, Longitude:	44.303056, -121.531944 (est)

Administrative Information

Investigator In Charge (IIC):	Elliott Simpson	Report Date:	05/13/2015
Additional Participating Persons:	Tony Moore; Federal Aviation Administration FSDO; Portland, OR Roger Knoll; Bundesstelle für Flugunfalluntersuchung (BFU); Braunschweig, Jordan Paskevich; Rotech Flight Safety; Vernon, Thomas Paghiny; Flight Design; Woodstock, CT Arian L Foldan; Flight Design USA; Woodstock, CT		
Publish Date:	05/13/2015		
Note:	The NTSB did not travel to the scene of this accident.		
Investigation Docket:	http://dms.nts.gov/pubdms/search/dockList.cfm?mKey=87946		

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. A factual report that may be admissible under 49 U.S.C. § 1154(b) is available [here](#).