Aviation Investigation Final Report

Location:	Addison, Texas	**Accident Number:**	CEN18LA119
Date & Time:	March 10, 2018, 16:46 Local	**Registration:**	N422PS
Aircraft:	CZECH SPORT AIRCRAFT AS PIPER SPORT	**Aircraft Damage:**	Substantial
Defining Event:	Fuel related	**Injuries:**	2 Serious
Flight Conducted Under:	Part 91: General aviation - Instructional		

Analysis

According the operator, before the flight, the airplane was serviced with winter-grade 93-octane automotive gas. The flight instructor and one passenger were conducting a local introductory instructional flight; the outside ambient temperature was 81°F. The airplane's recorded data showed that the engine was running for about 18 minutes during engine start-up, taxi, engine run-up, and while holding short of the runway. During the engine run-up, the fuel flow was about 6 gallons per hour (gph), and the fuel pressure was between about 6 and 7 pounds per square inch (psi) at an engine speed of 4,000 rpm.

Shortly after departure, the pilot stated to an air traffic controller that "we're having vapor lock, we need to come back and land." During the initial climb, the fuel flow increased to a peak of 9 gph, and the fuel pressure decreased to 3.3 psi at 5,025 rpm. The airplane made a climbing left turn to the southeast, continued circling left as the engine surged, and then descended toward the end of the departure runway before the flight track data ended. An airport surveillance video showed that, the airplane subsequently continued descending in a wings-level attitude near the end of the runway before it entered a sharp left bank and then impacted the ground.

Examination of the airplane revealed no evidence of any preexisting mechanical malfunctions or failures that would have precluded normal operation. Although the engine manufacturer recommended the use of mogas; however its Engine Operating Manual (EOM) warned to only use “fuel suitable for the respective climatic zone” and that there was a “risk of vapor formation if using winter [grade] fuel for summer operation.”

The EOM stated that the fuel flow at takeoff is 7.1 gph. When an engine experiences vapor lock, air enters the fuel flow sensor and causes the unit to spin at a higher rate than if only fuel was passing through, and it is often represented as spikes in fuel flow. Therefore, the fuel flow reaching 9 gph during the initial climb was consistent with vapor lock. It is likely that, due to the use of a winter-grade fuel and

the high ambient outside temperature, fuel vapor formed in the fuel system, which resulted in vapor lock and a partial loss of engine power.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The operator's use of improper fuel, which resulted in partial loss of engine power due to vapor lock.

Findings

Aircraft	Fuel - Fluid type
Organizational issues	Adequacy of documents/info - Operator
Organizational issues	Adequacy of policy/proc - Operator
Organizational issues	Safety - Operator
Personnel issues	Incorrect action performance - Ground crew
Environmental issues	High temperature - Contributed to outcome

Factual Information

History of Flight

Initial climb	Fuel related (Defining event)
Initial climb	Off-field or emergency landing
Emergency descent	Collision with terr/obj (non-CFIT)

On March 10, 2018, at 1646 central standard time, a Czech Sport Aircraft Piper Sport airplane, N422PS, impacted terrain at Addison Airport (ADS), Addison, Texas. The flight instructor and one passenger sustained serious injuries and the airplane sustained substantial damage. The airplane was registered to a private individual and operated by Excite Aircraft, Inc., doing business as US Sport Aircraft under the provisions of Title 14 *Code of Federal Regulations* Part 91 as an introductory/instructional flight. Day visual meteorological conditions prevailed at the time of the accident and no flight plan had been filed. The local flight departed ADS at 1644.

A review of the air traffic control audio recording revealed that at 1642 the pilot requested a takeoff clearance while holding short of runway 15. At 1643 the controller instructed the pilot to line up and wait on runway 15. At 1644 the controller cleared the airplane for takeoff. At 1646 the pilot stated to the controller "we're having vapor lock, we need to come back and land." There were no further recorded communications from the pilot.

Witnesses observed the accident airplane during the event and reported that the airplane flew over the southeast side of the airport. The airplane descended out of view behind several hangars and then climbed above the hangars. The airplane made a left climbing turn toward the runway and then descended again until it impacted terrain on the east side of the runway 33 threshold.

Recorded flight track data indicated that the airplane departed runway 15 and made a climbing right turn to the southeast, then continued circling left toward the runway before the data ended near the accident site. Figure 1 depicts the final flight track in red overlaid on Google Earth.

Figure 1 – Final flight track in red overlaid on Google Earth.

A review of the airport surveillance video revealed that at 1646 the airplane was flying southeast above the end of runway 15 and headed south. The airplane descended in a wings level attitude near the end of runway 15 before it made sharp left bank turn and impacted the ground.

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	20,Female
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane single-engine	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	June 21, 2017
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	August 31, 2017
Flight Time:			

Passenger Information

Certificate:		**Age:**	37,Female
Airplane Rating(s):		**Seat Occupied:**	Left
Other Aircraft Rating(s):		**Restraint Used:**	4-point
Instrument Rating(s):		**Second Pilot Present:**	No
Instructor Rating(s):		**Toxicology Performed:**	No
Medical Certification:		**Last FAA Medical Exam:**	
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:			

Aircraft and Owner/Operator Information

Aircraft Make:	CZECH SPORT AIRCRAFT AS	**Registration:**	N422PS
Model/Series:	PIPER SPORT	**Aircraft Category:**	Airplane
Year of Manufacture:	2010	**Amateur Built:**	
Airworthiness Certificate:	Special light-sport (Special)	**Serial Number:**	P1001010
Landing Gear Type:	Tricycle	**Seats:**	2
Date/Type of Last Inspection:	November 18, 2017 100 hour	**Certified Max Gross Wt.:**	1320 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	1994.4 Hrs as of last inspection	**Engine Manufacturer:**	Rotax
ELT:	Installed	**Engine Model/Series:**	912 ULS
Registered Owner:		**Rated Power:**	98 Horsepower
Operator:		**Operating Certificate(s) Held:**	None
Operator Does Business As:	US Sport Aircraft	**Operator Designator Code:**	

According to the operator's agenda from a staff instructor meeting on December 28, 2017, the company mechanic discussed different fuel blends and vapor lock formation. The agenda notes stated that if the temperature is over 70°F in the winter, then they should add 100LL avgas for a 50/50 mixture of avgas and automotive gasoline (mogas). The notes also mentioned that the airplane fuel pump would not fix vapor lock.

According to the operator, before the flight the airplane was serviced with 93-octane mogas, which was stored in their fuel bowser after it was purchased from a local gas station. The bowser was quarantined after the accident and not used for company operations.

The engine manual noted that the fuel flow at takeoff performance is 7.1 gph.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KADS,644 ft msl	**Distance from Accident Site:**	1 Nautical Miles
Observation Time:	15:47 Local	**Direction from Accident Site:**	341°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	9 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	180°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.68 inches Hg	**Temperature/Dew Point:**	27°C / 13°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Addison, TX (ADS)	**Type of Flight Plan Filed:**	None
Destination:	Addison, TX (ADS)	**Type of Clearance:**	VFR
Departure Time:	16:44 Local	**Type of Airspace:**	Class D

Airport Information

Airport:	ADDISON ADS	**Runway Surface Type:**	Asphalt
Airport Elevation:	644 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	15	**IFR Approach:**	None
Runway Length/Width:	7203 ft / 100 ft	**VFR Approach/Landing:**	Forced landing

Wreckage and Impact Information

Crew Injuries:	1 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Serious	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Serious	**Latitude, Longitude:**	32.958889,-96.831665(est)

The airplane impacted the taxiway and came to rest upright in the grass between taxiway A and the runway. The airplane impacted in a left wing and nose low attitude and skidded upright until it came to rest. The airplane's left wing was broken up and aft. The forward fuselage at the instrument panel was broken down. The airplane was recovered to the operator's hangar, then relocated to a secure storage facility where a postaccident examination was completed.

The mechanical fuel pump was actuated by hand and produced a yellowish liquid similar to look and smell of mogas. A sample of the liquid tested negative for water and did not contain any contaminants. No preimpact mechanical malfunctions or anomalies were found that would have precluded normal operation.

The fuel return line was installed in a slightly different location than shown in the Czech Sport Aircraft maintenance manual. The fuel return line was installed after a junction after the mechanical fuel pump and before the fuel flow transducer. The maintenance manual showed that the fuel return line should be installed after the fuel flow transducer and before the carburetors. Czech Sport Aircraft stated that the fuel return line was installed appropriately and is the same configuration used at their factory. The location of the fuel return line would not have increased the risk of vapor lock.

Engine Monitor

The airplane was equipped with a Dynon engine monitoring system which recorded engine parameters including oil pressure and temperature, fuel pressure and flow, manifold pressure, engine speed, and the cylinder and exhaust gas temperatures (CHT, EGT). The unit also recorded the airplane's GPS position, ground speed, and altitude. Examination of the data revealed that the engine was running for about 18 minutes during engine startup, taxi, engine runup, and while holding short of the runway. During the runup, the fuel flow reached about 6 gallons per hour (gph) and fuel pressure was 6 to 7 psi at an engine speed of 4,000 rpm. During the initial climb, the fuel flow increased to a peak of 9 gph and the fuel pressure decreased to 3.3 psi at 5,025 rpm. In the next 40 seconds the rpm decreased to 3,043 and the fuel flow dropped to 7.8 gph. About 10 seconds later, the rpm had increased back over 5,000 rpm, then decreased to 3,000 rpm in the next 10 seconds. The data ended about 15 seconds later.

A review of the historical data for the last 10 flights (March 2, 2018 through March 10, 2018), fuel flow consistently reached 7.25 to 8.3 gph during each takeoff. The fuel flow was highest during afternoon flights as the outside air temperature increased to about 75° F. The only time the fuel flow increased higher was during the accident flight where it ranged 8.937 to 9.0 gph in a 10 second span.

Additional Information

Fuel Flow Sensor

According to technical representatives from Electronics International Inc. (EI), who manufacture the airplane's fuel flow sensor, when air inadvertently enters a rotor style flow transducer through the fuel lines, the rotor is free to spin at the velocity of the air that passes over it. This velocity is higher for air than it is for fuel, and as such "vapor lock" is often represented as spikes in fuel flow. Additionally, with air in the system, pulses of air from the fuel pump can cause the rotor to spin back and forth in both directions. Under these conditions, the pickup still measures flow irrespective of direction, resulting in "jumping" fuel flow readings.

Fuel Types

Although the engine was capable of operating on 100 low-lead aviation gasoline, Rotax Engines recommended the use of mogas because the lead in aviation fuel can cause stress on the valve seats, as well as create excessive lead deposits within the combustion chamber. The airplane's pilot operating handbook (POH) made similar recommendations, with the caveat that aviation gasoline should only be used, "in case of problems with vapor lock or when other types of gasoline are unavailable."

Rotax Engines and Czech Sport Aircraft recommended using mogas which meets the American Society for Testing and Materials (ASTM) standard D4814. The Rotax operating manual, and placards mounted throughout the airplane, indicated that fuel with a minimum RON of 95 and anti-knocking index (AKI) of 91 can be used. Rotax further stated in the engine operating manual, "Use only fuel suitable for the respective climatic zone", and "Risk of vapor formation if using winter fuel for summer operation."

Fuel System

On September 11, 2017, Rotax-Owner.com published an Information Safety Notice highlighting the Rotax Installation Manual (IM) 73-00-00 guidance for the fuel return line. The notice repeated that the fuel return line is mandatory to be incorporated within the fuel system. The purpose of the fuel return line is to bleed off any vapors that may form within the fuel system that could cause vapor lock, resulting in a possible loss of engine power. On September 21, 2017, Rotax-Owner.com sent a notification to the public regarding the Information Safety Notice.

After the accident on August 30, 2018, Czech Sport Aircraft issued Safety Alert SA-SC-011, which provided a set of updates to the airplane's operating handbook regarding engine operation to limit the possibility of vapor lock. One of the updates required the following addition to all sections of the POH that mentioned fuel, "WARNING - Use only fuel formulated for the specific climate zone. Pay special attention to the current outside air temperature. Do not use winter mogas blends in warmer than normal temperatures. Risk of vapor formation if winter fuel is used for summer operation."

Tests and Research

Due to the fuel system impact damage there was not enough fuel available for testing. Fuel from the operator's fuel bowser was recovered and sent to a private laboratory for testing, which concluded that the research octane number (RON) was 98.3 and the vapor pressure was 12.79 psi. Winter grade fuel can be as high as 13 psi, but summer grade fuel must be below 9 psi; therefore, the tested fuel was winter grade.

Administrative Information

Investigator In Charge (IIC):	Lindberg, Joshua
Additional Participating Persons:	Greg Sheehan; Federal Aviation Administration; Irving, TX Jordan Paskevich; Rotech Flight Safety; Vernon Miroslav Koukal; Czech Aircraft Group
Original Publish Date:	May 5, 2021 **Investigation Class:** 2
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=96854