Aviation Investigation Final Report

Location:	Paulding, Ohio	**Accident Number:**	CEN18LA064
Date & Time:	December 28, 2017, 16:30 Local	**Registration:**	N4JW
Aircraft:	PIPISTREL DOO AJDOVSCINA VIRUS SW	**Aircraft Damage:**	Substantial
Defining Event:	Fuel starvation	**Injuries:**	1 None
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The airline transport pilot was conducting a local flight in his motor-powered glider. The pilot had the right fuel tank selected and was flying in a counterclockwise direction around a ground reference point when the engine began to lose power. The pilot switched fuel tanks with no improvement and selected a nearby road for a forced landing. During the landing roll on the ice-covered road, the glider's left wing impacted a bush, and the glider exited the road; the nosewheel broke off when it impacted a ditch.

The flight manual indicated that all basic nonaerobatic maneuvers are permitted within the operational speed range, which included steep turns with a maximum bank of 60°. The recommended fuel, per the flight manual, was an unleaded super grade. A warning directed that use of fuel with alcohol content and/or other additives is not permitted. Testing of recovered fuel revealed that it contained about 5% alcohol. However, examination of the fuel system revealed no evidence of preimpact malfunctions or failures that would have precluded normal operation, and the engine was operational during a postaccident engine run.

Although the pilot reported the glider had 5 to 6 gallons of fuel in each of the two main tanks, a second engine test run was conducted where the engine was intentionally fuel starved. Data from the avionics and engine computers were then downloaded, plotted, and compared to data from the accident flight. Both the accident data and the fuel starvation test data similarly showed the engine began to run roughly as the rpm and fuel flow began to fluctuate. Additionally, avionics data showed that both the accident flight data and the fuel starvation test run data had similar indications.

The glider's GPS tracked the accident flight from the point of takeoff to the point of the forced landing. This GPS data and the engine data were plotted to determine where the fluctuating engine rpm consistent with engine roughness and the loss of engine power occurred. The glider departed, climbed, and made multiple left turns with multiple altitude changes. The data showed the glider was in a left climbing turn when the engine began to lose power after fluctuations in engine rpm.

Based on the available data, it is likely the fuel unported during the glider's climbing turn, which resulted in fuel starvation and the loss of engine power.

Probable Cause and Findings

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

The loss of engine power while the motor-powered glider was maneuvering due to the fuel unporting in its fuel tank, which resulted in fuel starvation and a subsequent forced landing on unsuitable terrain.

Findings

Aircraft	Fuel - Not specified
Aircraft	Fuel - Fluid level
Aircraft	Lateral/bank control - Capability exceeded
Environmental issues	Snow/ice - Contributed to outcome
Environmental issues	Tree(s) - Contributed to outcome

Factual Information

History of Flight

Maneuvering	Fuel starvation (Defining event)
Maneuvering	Loss of engine power (total)
Emergency descent	Off-field or emergency landing
Landing	Collision with terr/obj (non-CFIT)

On December 28, 2017, about 1630 eastern standard time, a Pipistrel Doo Ajdovscina Virus SW motorized glider, N4JW, impacted terrain during a forced landing on a road following a loss of engine power near Paulding, Ohio. The airline transport pilot, who was the sole occupant, was uninjured. The glider sustained substantial wing damage when it exited the road and impacted vegetation and rough terrain. The glider was registered to and operated by the pilot as a Title 14 Code of Federal Regulations Part 91 personal flight. Day visual meteorological conditions prevailed in the area about the time of the accident, and the flight was not operated on a flight plan. The local flight originated from a private airport near Paulding, Ohio, about 1555.

The pilot reported the glider had 5 to 6 gallons of fuel in each of the two main tanks. In the right tank was 1 to 2 gallons of 100 low lead (LL) aviation gasoline and 5 gallons of "high test" automotive fuel. In the left tank was 5 gallons of 100LL as indicated by the fuel gauge sight tubes. The pilot had the right tank selected. He was flying in a counterclockwise direction around a ground reference point when the engine began to run rough. The glider engine indications showed fuel consumption at 1.7 gph at 4,500 rpm and 17 inches of mercury and an oil temperature of 173° F The pilot increased manifold pressure, turned on the auxiliary boost pump, and switched fuel tanks. The engine roughness increased so he switched back to the right fuel tank and for a few seconds the engine operation seemed better.

The pilot turned toward a private airstrip that was 3 miles east of his location. He was losing altitude and fighting a headwind. Realizing that he was not going to reach the airstrip, he selected a nearby road for a forced landing. The road was ice covered and provided very little braking. During rollout, the glider's left wing struck a bush just before a railroad crossing. The glider subsequently turned left and impacted a ditch where the glider's nose wheel broke off. The glider came to rest on the north side of the railroad tracks about 30 ft west of the road.

Pilot Information

Certificate:	Airline transport; Flight engineer; Flight instructor; Private	**Age:**	75,Male
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Glider	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	August 11, 2017
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	October 26, 2017
Flight Time:	(Estimated) 41000 hours (Total, all aircraft), 288 hours (Total, this make and model), 35000 hours (Pilot In Command, all aircraft), 61.9 hours (Last 90 days, all aircraft), 47.2 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	PIPISTREL DOO AJDOVSCINA	**Registration:**	N4JW
Model/Series:	VIRUS SW	**Aircraft Category:**	Glider
Year of Manufacture:	2017	**Amateur Built:**	
Airworthiness Certificate:	Experimental (Special); Restricted (Special)	**Serial Number:**	877 SWN 100 IS
Landing Gear Type:	Tricycle	**Seats:**	2
Date/Type of Last Inspection:	December 11, 2017	**Certified Max Gross Wt.:**	1350 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	4.55 Hrs as of last inspection	**Engine Manufacturer:**	Rotax
ELT:	C126 installed, not activated	**Engine Model/Series:**	912IS
Registered Owner:	On file	**Rated Power:**	100 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

According to the glider's flight manual, the Virus SW was certified as a Microlight/Ultralight aircraft and is equipped with a 100 horsepower, fuel injected Rotax 912 iS engine, and MT Propeller model MTV-33 propeller. The Rotax 912 iS engine is equipped with two sets of fuel injectors, two electrical generators, two engine computers (ECU), dual ignition, and dual high-pressure electrical fuel pumps. The fuel system fuel selector is centrally located, with two feeds and two return lines, which incorporate quick disconnect fittings. The fuel selector has L[eft], R[right], and OFF positions.

Electrical System

The glider's electrical system is controlled by the engines fuse box and ECUs. The engine is equipped with two integrated permanent-magnet electric generators, which do not require any outside voltage to be applied for their function. Generator 1 is a 20-amp main generator, which powers all of the engine's vital systems as the ignition, fuel pumps, fuel injectors, and ECUs. Generator 2 is the on-board generator, which powers all of the avionics and glider systems to include the electrical constant speed propeller and instrument panel illumination. There are warning lights that indicate the malfunction of a certain generator; however, the fuse box is able to bridge loads from Generator 1 to Generator 2 in case of a failure automatically, to keep the engine running. The pilot cannot manually select Generator 1 or Generator 2 to be in function. In the event that Generator 1 fails, and Generator 2 is overloaded when supporting both the engine and avionics, the system will de-rate power on the avionics bus. Turning the emergency battery switch ON will bring the battery into the system to support the electrical load. During normal engine operation, with Generator 1 and Generator 2 functioning normally, the battery is charged by the system and not used to support loads. The only sources of electrical power during normal operations are the generators. The emergency battery switch when turned ON is also able to support the operation of the engine and other on-board loads for up to 30 minutes.

Operating Limitations

Per the flight manual, all basic non-aerobatic maneuvers are permitted within the operational speed range, which includes steep turns with a maximum bank of 60° and initial speed of 160 km/h (85 kts).

The flight manual also states that, due to flight safety reasons, it is forbidden to fly when the outside air temperature reaches 40°C or higher and perform any form of aerobatic flying. There is no limitation listed for a minimum temperature.

The recommended fuel is an unleaded super grade with a research octane number rating of 95 (anti-knock index 912 and up) and no alcohol content. Also approved are leaded fuels or AVGAS 100LL; however, use of these fuels reduces engine life. An engine oil change every 50 flight hours is crucial if leaded fuel is used. And the flight manual warns that use of fuel with alcohol content and/or other additives is not permitted.

Emergency Procedures

Rough engine operation or engine failure in flight

The flight manual states in part:

First ensure proper airspeed (64 kts), then start analyzing terrain underneath and choose the most appropriate runway or site for landing out.

Provided the engine failed aloft, react as follows:

Make sure the master switch is in the ON position, Fuel selector to fuller tank. Fuel pumps - set both ON. Attempt to restart the engine. If unsuccessful, begin with the landing out procedure immediately.

Engine failures

The flight manual states in part:

LANE failures
Failure modes of LANEs are indicated with 2 (two) LANE LED lights, designated LANE A and LANE B on the main electrical panel. The lights indicate three modes:

LED OFF - proper healthy operation, no malfunction

LED intermittent (blinking) - abnormal operation, pilot is advised to manually switch to the remaining healthy LANE. It is recommended to land soon and inspect engine systems to discover fault

LED ON (permanent) - LANE failure, pilot MUST manually switch over to healthy LANE and end as soon as possible.

Fuel Pump

The glider's fuel system uses two redundant high-pressure fuel pumps. If a pump fails, the other pump takes over its role. Only one functional pump is required for the engine to function normally. In the case of a pump failure, the pilot should switch over to the other pump. Should the engine quit before the pump is activated, the pilot should restart engine normally. Should both fuel pumps fail, the engine cannot be restarted as not enough fuel pressure is produced.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KDFI,707 ft msl	**Distance from Accident Site:**	15 Nautical Miles
Observation Time:	15:53 Local	**Direction from Accident Site:**	55°
Lowest Cloud Condition:	Scattered / 10000 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	140°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.53 inches Hg	**Temperature/Dew Point:**	-12°C / -18°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Paulding, OH	**Type of Flight Plan Filed:**	None
Destination:	Paulding, OH	**Type of Clearance:**	None
Departure Time:	15:55 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 None	**Latitude, Longitude:**	41.188888,-84.708053(est)

Federal Aviation Administration (FAA) inspectors examined and documented the wreckage at the scene. The left wing tip sustained crush damage and had embedded ground vegetation and broken branches. Snow on the ground showed linear depressions that led from the roadway and ended at the wreckage.

Flight recorders

The glider was equipped with two Dynon SV-HDX1100 units. The units have a 10-inch screen with both a touchscreen and softkey interface. The Dynon units can serve as either a Primary Flight Display (PFD) or a Multifunction Display (MFD) depending on installation. The units have a solid-state Air Data and Attitude Heading Reference System (ADAHRS) that displays glider parameter data including altitude, airspeed, attitude, vertical speed, and heading. The units also have external pitot/static inputs for altitude, airspeed, and vertical speed information. The units contain an internal flash memory device that stores information sampled every 60 milliseconds for the last two hours of flight in a file called a "Black Box Log." Detailed alert logs that show both caution, warning and aural alerts generated by the display are stored in a file called "Alert Data," as well as a flight history log, which is sampled at a lower rate that can record many more hours of operation. The flight history is recorded as a file called "User Log" and is sampled about every 130 milliseconds.

Tests and Research

The glider was recovered to the owner's hangar and later examined by quarantined there. FAA inspectors, a technical advisor from the engine manufacturer, and the National Transportation Safety Board (NTSB) investigator-in-charge (IIC).

The Dynon units were removed. The ECU was downloaded and subsequently removed. The contents of both fuel tanks were checked for water with color cut paste and no water was detected. The paste was checked for its ability to detect water and it subsequently indicated the presence of water when water was applied to it. The auto fuel was checked for alcohol using a Daansen 391S sampler and it appeared that the auto fuel contained about 5% alcohol. The 2 inline fuel filters were not obstructed. The gascolator filter was not obstructed. The fuel line from the firewall mounted fine filter to the engine was opened. Both electric fuel pumps in the dual pump unit were able to pump fuel from both fuel tank lines located behind the seats to the fuel line to the engine. The vents on both fuel tanks were not obstructed. No anomalies were detected in the fuel system. The dual fuel pump unit was removed. Removed sparkplugs exhibited a coloration consistent with normal. The engine showed compression at all cylinders when the propeller was rotated by hand. The oil tank filler neck expelled a burp sound when the propeller was rotated by hand indicative that oil was present in the oil tank.

The engine ECU, dual fuel pump unit, and fuse box were sent to a Rotax aircraft engine overhaul and testing facility for examination under the supervision of an NTSB air safety investigator. The engine was subsequently mounted for testing. The engine was started and ran at idle for several minutes until the operating temperatures were within normal operational range. The first engine test run was 23 minutes and 38 seconds in duration and the accident engine ECU's data was plotted. All engine parameters and fuse box indications were normal, and no anomalies were noted in the plotted data.

A second engine test run was conducted with a reduced amount of fuel in fuel tank. The purpose of this second test run was to record how the accident engine would react when it was run out of fuel, and to analyze its ECU data. During this second test run, no anomalies were noted and all engine parameters were normal until the engine began to run rough as it was running out of fuel.

ECU data showed that at 10 minutes and 44 seconds into the second engine test run, as the engine began to run rough, the RPM and fuel flow begin to fluctuate. This lasted for 19 seconds when a reduction in RPM and fuel flow was observed. Over the next 7 seconds, the RPM dropped from 5,206 RPM to 515 RPM. The throttle position remained consistent between 94% and 100% throughout the loss of power sequence, until it was manually manipulated following the drop in RPM. Manipulation of the throttle lever did not result in any changes to engine parameters.

The ECU data from the engine tests were compared with the data from the accident. The ECU data from the accident flight showed the engine begin to run rough as the RPM and fuel flow begin to fluctuate for approximately 6 seconds until a reduction of RPM was seen. The RPM and fuel flow dropped from 4,892 RPM to 2,766 RPM over a 15 second time span and the throttle position remained consistent between 93% and 96% throughout this portion of the loss of power sequence.

Both the accident ECU data and the fuel starvation test ECU data exhibited similarities with the data as RPM showed notable fluctuations in engine RPM and fuel flow just prior to drop in RPM.

No airframe or engine preimpact mechanical malfunctions or failures with were noted during the examination and test runs.

The Dynon SV-HDX1100 units were examined at the NTSB Vehicle Recorder Laboratory, Washington, DC. The data was downloaded and showed the left display configured to function as a PFD, and the right display as a MFD.

The PFD's User Log contained records of several flights and power cycles between December 18, 2017, and December 28, 2017. The Alert Data log contained caution and warning information and aural alert records October 10, 2017 and December 28, 2017, on all three data files. The Black Box Log file contained high rate data between December 27, 2017, and December 28, 2017. The accident flight was associated with the logs created on December 28, 2017, on all three data files. The duration of the accident recording on December 28, 2017, was approximately 18 minutes and 49 seconds. Log files were reviewed from the MFD and matched those of the PFD described above. There was no additional engine data recorded in any of the MFD's log files.

The flight parameters were plotted along with most significant recorded engine parameters for the entire accident flight. Alert data from the "Alert Data" log was overlaid on the plot. At 21:10:25, the autopilot was shown as engaged in mode "3" (autopilot control in both pitch and roll axis). Between 16:10:48 and 16:14:40, the "Alert Data" log showed multiple aural alerts of the autopilot being connected and disconnected. At 16:14:12, an alert for "AP Mode – Airspeed Low" was issued. At 16:14:41, an aural alert for "Fuel Pressure Low" was issued by the system. The trace for fuel pressure at this time dropped to 25 psi, 7 seconds after the "Fuel Pressure Low" alert was issued. Values for fuel pressure and fuel flow continued to fluctuate and drop for the remainder of the recording. Values for throttle position and manifold pressure continued to fluctuate and drop as well. Altitude first increased after the "Fuel Pressure Low" alert, and then decreased for the remainder of the recording. Data ended at 16:18:42. Plotted data show the glider's groundtrack during the accident flight and its groundtrack during the final portion of flight.

Monitoring and recording of the fuel pressures is done through the Dynon units. The accident flight fuel pressure data was also analyzed and compared with the fuel pressures taken during the fuel starvation engine test run. The comparison showed that there was a drop in fuel pressures on both the accident flight data and the fuel starvation test run data. Both the accident flight data and fuel starvation test run data had similar indications of pressure drops following a rise in pressure.

GPS data captured the glider's accident flight from the point of take-off to the where the forced landing occurred, and the glider came to rest. The GPS data and the engine ECU data were plotted to determine where fluctuating engine RPM consistent with engine roughness and loss of engine RPM/power occurred. The data showed the glider's departure, climb, and multiple left hand turns with multiple altitude changes.

The data showed the glider in a left-hand climbing turn when the engine RPM began fluctuating and the engine began to lose power.

Additional Information

In his written statement to the NTSB, the pilot related, in part that, "After a great deal of thought, I am very upset about the time wasted trying to read the fuel gauges (sight tubes for fuel overhead in the Virus airplane). Years of flying would say to check the fuel quantity at a loss of power with no other indication is the lack of fuel. In-flight with the engine running rough it is virtually impossible to read the site gauges late in the day with us unload in the west. Neither the left nor the right sight gauge was readable.

Having flown the BD/Grumand single engine aircraft for many hours their site gage with the contrasting color little bead in the sight tube is a huge improvement compared to looking for the meniscus of the fuel. From the Dictionary is the definition of meniscus ((physics) the curved upper surface of a non-turbulent liquid in a vertical tube). The keyword here I feel is non-turbulent."

Administrative Information

Investigator In Charge (IIC):	Malinowski, Edward
Additional Participating Persons:	Paul Gillenwater; Federal Aviation Administration; Columbus, OH Jordan Paskevich; Rotax Aircraft Engines; Vernon B.C Don Jones; Dynon Avionics; Woodinville, WA Leon Brecelj; Pipistrel; Ajdovscina Karmen Potocar; Air Accident and Incident Investigation Unit; Ljubljana Christoph Ringl; Austrian Ministry for Transport, Innovation and Te; Vienna
Original Publish Date:	November 6, 2019
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=96545