Aviation Investigation Final Report

Location:	Kidron, Ohio	**Accident Number:**	CEN19LA056
Date & Time:	January 21, 2019, 09:12 Local	**Registration:**	N467KS
Aircraft:	Douglas DC3C	**Aircraft Damage:**	Substantial
Defining Event:	Loss of control in flight	**Injuries:**	2 Fatal
Flight Conducted Under:	Part 91: General aviation - Positioning		

Analysis

The two pilots departed in a turbine powered DC-3C at maximum gross weight for a repositioning flight. The airplane was part of a test program for new, higher horsepower engine installation. Soon after liftoff and about 3 seconds after decision speed (V1), the left engine lost total power. The propeller began to auto-feather but stopped feathering about 3 seconds after the power loss. The airplane yawed and banked to the left, descended, and impacted terrain.

Recorded engine data indicated the power loss was due to an engine flameout; however, examination of the engine did not determine a reason for the flameout or the auto-feather system interruption. While it is plausible that an air pocket developed in the fuel system during the refueling just before the flight, this scenario was not able to be tested or confirmed. It is possible that the auto-feather system interruption would have occurred if the left power lever was manually retarded during the auto-feather sequence.

The power loss and auto-feather system interruption occurred during a critical, time-sensitive phase of flight since the airplane was at low altitude and below minimum controllable airspeed (Vmc). The acutely transitional phase of flight would have challenged the pilots' ability to manually feather the propeller quickly and accurately. The time available for the crew to respond to the unexpected event was likely less than needed to recognize the problem and take this necessary action – even as an immediate action checklist/memory item.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:
The loss of airplane control after an engine flameout and auto-feather system interruption during the takeoff climb, which resulted in an impact with terrain.

Findings

Aircraft	(general) - Inoperative
Aircraft	Propeller feather/reversing - Inoperative
Aircraft	Engine out control - Malfunction
Personnel issues	(general) - Flight crew

Factual Information

History of Flight

Initial climb	Powerplant sys/comp malf/fail
Initial climb	Loss of control in flight (Defining event)
Initial climb	Collision with terr/obj (non-CFIT)

On January 21, 2019, at 0912 eastern standard time, a Douglas DC-3C airplane, N467KS, was substantially damaged when it was involved in an accident in Kidron, Ohio. The two pilots were fatally injured. The airplane was operated as a Title 14 Code of Federal Regulations Part 91 positioning flight.

The airplane was the prototype for an Amended Supplemental Type Certificate (STC) project to add newer model Pratt and Whitney Canada (P&WC) PT6A series engines and MT propellers to the existing STC. Following several project meetings with the Federal Aviation Administration (FAA), certification and flight test plans were created. The airplane was loaded with ballast to maximum gross weight and was being positioned from Stoltzfus Airfield (OH22), Kidron, Ohio, to Akron Canton Regional Airport (CAK), North Canton, Ohio, to pick up a FAA test pilot for initial flight testing of stall maneuvers.

The cockpit voice recorder (CVR) began recording before takeoff, about 0902. According to the recording, the captain elected to forego the auto-feather system and overspeed governor tests that were listed in the "run up" section of the normal checklist because of the snow packed conditions on the taxiway and runway. As the captain was completing the before takeoff checklist, he stated all four boost pumps were on and all annunciator panel lights were extinguished. The captain briefed the takeoff decision speed (V1), rotation speed (Vr) and climb speed (V2) of 82, 84, and 90 knots, respectively.

The takeoff roll began and the first officer stated "takeoff power" at 0911:13, "40 knots" at 0911:16, "60 [knots] crosscheck" at 0911:19, and "V1" at 0911:24. Soon after liftoff, at 0911:27, the captain noticed a problem and called for landing gear up. At 0911:31, a sound similar to the annunciator panel audible alarm occurred. At 0911:35 and 0911:39, the captain made brief comments that indicated he was struggling to fly the airplane. At 0911:40, the airplane impacted terrain.

Witnesses observed white smoke exiting the left engine exhaust system immediately after takeoff and the airplane banked and yawed left. The airplane subsequently descended and struck power lines and trees before impacting terrain.

Downloaded automated data acquisition system (ADAS) data indicated left engine torque, fuel flow, gas generator speed (Ng), propeller rpm (Np) rapidly decreased at 0911:26.5. At 0911:27.2, left engine torque dropped to nearly zero and Ng decreased until the end of the recorded data.

Left engine Np dropped to 746 rpm at 0911:30, then increased to 1050 rpm about 4 seconds later. Airspeed reached a maximum of 91 knots at 09:11:31. By the end of recorded data at 0911:41, Np and airspeed had decreased to 971 rpm and 73 knots, respectively.

Correlated ADAS data and CVR events are shown in Figure 1.

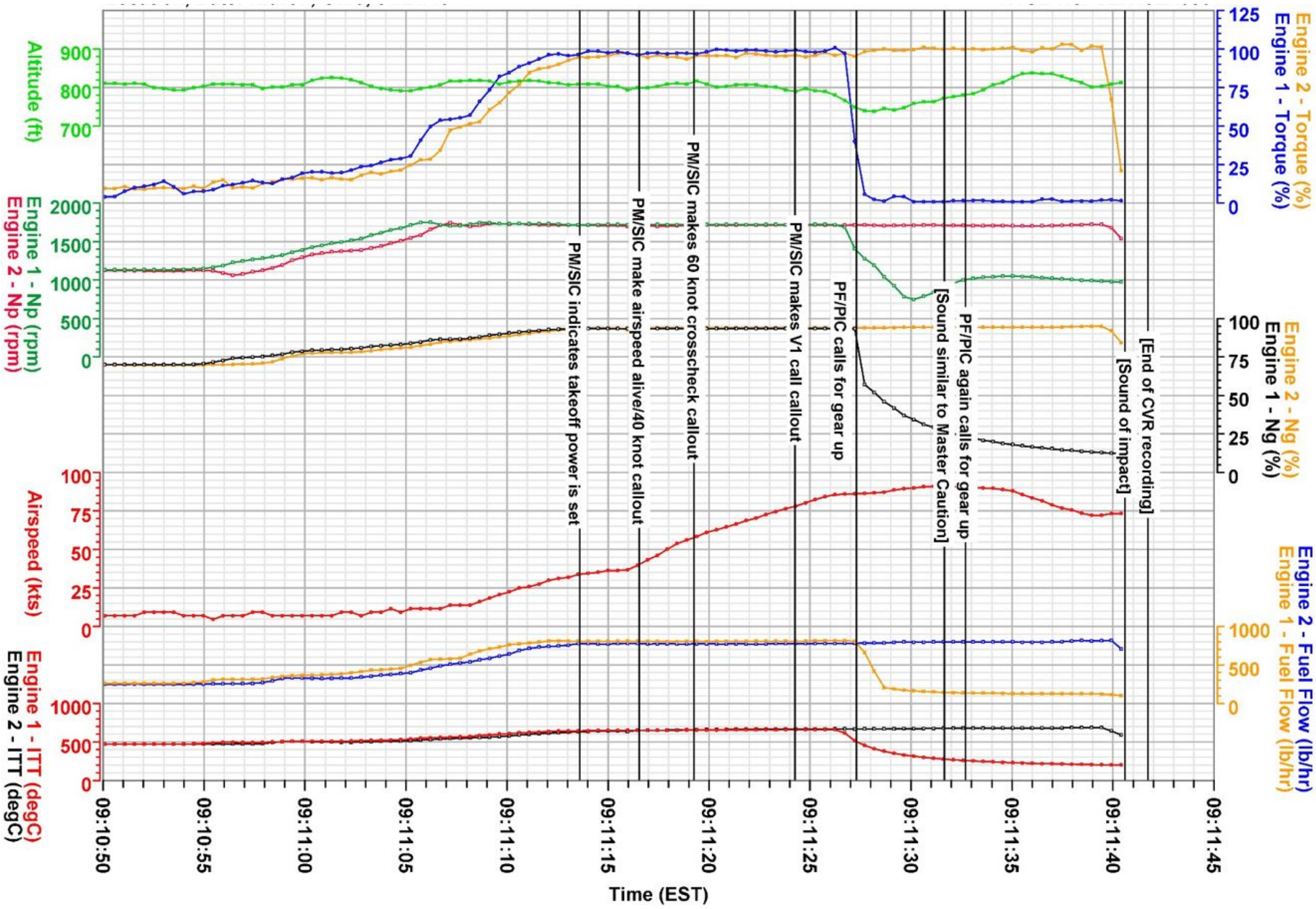

Figure 1 - Correlated ADAS Data and CVR Events

Pilot Information

Certificate:	Airline transport	**Age:**	55,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:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	November 12, 2018
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	November 14, 2018
Flight Time:	15457 hours (Total, all aircraft), 5612 hours (Total, this make and model), 14950 hours (Pilot In Command, all aircraft), 35 hours (Last 90 days, all aircraft), 6 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

Co-pilot Information

Certificate:	Airline transport	**Age:**	56,Male
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:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	October 9, 2018
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	January 24, 2018
Flight Time:	9969 hours (Total, all aircraft), 12 hours (Total, this make and model), 5235 hours (Pilot In Command, all aircraft), 46 hours (Last 90 days, all aircraft), 10 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

Captain

The captain was a DC-3TP Part 125 check airman and was the chief pilot for AFM Hardware Inc.; he held FAA designated pilot examiner privileges for both piston and turboprop DC-3 airplanes. The accident flight was the captain's eighth flight in the accident airplane after installation of the newer model PT6A series engines.

First Officer

The accident flight was the first officer's fourth flight in the accident airplane after installation of the newer model PT6A series engines.

Aircraft and Owner/Operator Information

Aircraft Make:	Douglas	**Registration:**	N467KS
Model/Series:	DC3C	**Aircraft Category:**	Airplane
Year of Manufacture:	1942	**Amateur Built:**	
Airworthiness Certificate:	Experimental (Special)	**Serial Number:**	20175
Landing Gear Type:	Retractable - Tailwheel	**Seats:**	7
Date/Type of Last Inspection:	July 20, 2018 AAIP	**Certified Max Gross Wt.:**	29000 lbs
Time Since Last Inspection:	11 Hrs	**Engines:**	2 Turbo prop
Airframe Total Time:	37504 Hrs as of last inspection	**Engine Manufacturer:**	P&W Canada
ELT:	C126 installed, activated, did not aid in locating accident	**Engine Model/Series:**	PT6A
Registered Owner:	Priority Air Charter LLC	**Rated Power:**	
Operator:	AFM Hardware Inc	**Operating Certificate(s) Held:**	Other operator of large aircraft

The airplane was issued an experimental airworthiness certificate on July 27, 2018.

Fuel System

The fuel system consisted of four auxiliary tanks and two main tanks having a total capacity of 1,041 gallons. The four auxiliary tanks were mounted in the wing center section and one main tank was mounted in each engine nacelle. Each main tank had a capacity of 116 gallons, split into eight sections by integral baffles. Main tank fuel was routed through two boost pumps with check valves to the engine fuel pump, which included a low fuel pressure sensor that activated a cockpit audible warning tone below 5 psi.

An electrically operated firewall fuel shutoff valve was mounted on the aft side of the engine firewall. Forward of the engine firewall was a fuel strainer with a red "popup" indicator, designed to "pop" if fuel bypass was activated.

One week before the accident, all six fuel tanks were defueled for weight and balance calculations. On the morning of the accident, the airplane was towed from a heated hangar and all six tanks were filled with Jet A1 fuel, totaling 1,046 gallons. The two main fuel tanks were fueled via transfer from the forward auxiliary fuel tanks on each respective wing.

Propeller Auto-Feather System

The composite, five bladed propellers were constant-speed, full-feathering, single-acting, non-regulated propellers that used oil pressure from the propeller governor to decrease the pitch of the propeller blades to maintain the selected RPM. Increasing the propeller blade pitch is driven by an internal spring and counterweights to maintain the elected RPM.

In the event of a loss of engine power, an auto-feather system is installed to feather the propeller when there is a loss of propeller torque. The system consists of a feather dump valve located on the propeller overspeed governor of each engine, high and low-pressure switches located on the torque pressure manifold of each engine, an auto-feather switch located on the respective engine power lever, a propeller auto-feather switch on the instrument panel, and relays with associated electrical wiring.

When the auto-feather system is armed and the power lever position is above 90% Ng, the system automatically feathers the propeller when the engine torque drops below about 200 ft-pounds. Propeller feathering occurs when the auto-feather dump valve is activated, which releases the oil in the propeller, allowing the feathering spring and counterweights to drive the propeller blades to the feather position. Retarding the power lever to below 90% Ng will interrupt the auto-feather process.

Ignition System

The ignition system for each engine consists of one exciter box, two ignition leads, and two spark ignitors. A three-position ignition switch selects between auto, manual, and off positions. In the auto position, the system energizes whenever the starter is activated. In the manual position, the system provides continuous ignition.

The airplane was not equipped with an auto-relight ignition system, which is armed at takeoff and triggered by a low torque indication, causing the ignitors to fire automatically, relighting the fuel in the engine combustor.

The flight manual did not specify position of the ignition switch for normal takeoff. Following the accident, the operator updated the flight manual to require both engine ignition systems be switched to manual before takeoff to ensure continuous ignition.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KPHD,895 ft msl	**Distance from Accident Site:**	24 Nautical Miles
Observation Time:	08:53 Local	**Direction from Accident Site:**	137°
Lowest Cloud Condition:		**Visibility**	10 miles
Lowest Ceiling:	Overcast / 3200 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	9 knots / None	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:	290°	**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	30.48 inches Hg	**Temperature/Dew Point:**	-18°C / -22°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Kidron, OH (OH22)	**Type of Flight Plan Filed:**	IFR
Destination:	Akron, OH (CAK)	**Type of Clearance:**	None
Departure Time:	09:12 Local	**Type of Airspace:**	

Airport Information

Airport:	Stoltzfus Airfield OH22	**Runway Surface Type:**	Asphalt
Airport Elevation:	1130 ft msl	**Runway Surface Condition:**	Snow
Runway Used:	S	**IFR Approach:**	None
Runway Length/Width:	3460 ft / 45 ft	**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	2 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Fatal	**Latitude, Longitude:**	40.755554,-81.776947(est)

The airplane came to rest about 600 ft from the end of runway 19 and about 700 ft to the left of the runway centerline. The main wreckage was upright and oriented on a northwesterly heading, with the fuselage separated forward of the wings. The left wing was broken aft and the inboard leading edge of the right wing was crushed aft. The left engine was broken aft and was outboard of the wing's leading edge. The right engine was broken downward at the nacelle. The nose of the airplane was located forward and left of the main wreckage.

The left main tank was found inverted and breached. The fuel line from the left main tank to the engine was crimped during impact. All fuel line fittings were secure. The fuel filter bypass indicator, located on the engine side of the firewall, was in the normal position. Fuel samples from the four auxiliary fuel tanks, two main fuel tanks, and fuel farm were tested, with no anomalies observed.

The left engine power lever was about 1 inch forward of the idle stop and the right engine power lever was against the idle stop. The left propeller control lever was against the feather detent guard and the right propeller control lever was about 1 inch from the full forward position. The left fuel condition lever was against the stop in the ground idle position. The right fuel condition lever was forward in the run position.

The left engine propeller was still attached to the propeller shaft, with the five blades fractured near their roots. A dent in the pitch change pin corresponded to about 10-13° in flight, which was the low pitch hydraulic stop, which was consistent with a no or low power condition of the left engine.

The left engine propeller governor was fractured, and the speed adjust lever and return spring were not found. The input shaft was rotated by hand with no binding noted. The feathering valve was present and could be actuated with finger pressure. The reverse reset lever and the beta valve were actuated with no anomalies.

The left engine fuel control unit (FCU) was separated from the fuel pump. The fuel pump housing was fractured; however, the input spline was undamaged, and the input shaft was rotated by hand. The left engine compressor and power section, the left engine accessories consisting of the FCU, fuel pump, propeller governor, fuel nozzles and flow divider, and the right engine FCU were sent to the P&WC facility for further testing.

The autofeather system was examined, which revealed that the left engine power lever switch was operational. The autofeather switch on the instrument panel was destroyed and several system relays were damaged. The high- and low-pressure switches for the right engine were destroyed; the left engine switches tested normally. A review of cockpit videos from previous flights indicated the autofeather system operated normally during ground tests.

Examination of the left engine revealed signatures consistent with the engine producing very low power at the time of impact. Testing of the fuel nozzles and flow divider valve revealed no anomalies. The left engine fuel pump, propeller governor, and FCU were damaged and could not be functionally tested; however, disassembly showed no pre-impact anomalies that would have precluded normal operation. Testing of fuel from the FCU detected no water. The left engine examination did not reveal any pre-impact anomalies that would have precluded normal engine operation or caused an engine flame out.

Examination of the right engine revealed the propeller and power turbines rotated freely; however, there was no corresponding rotation between them, consistent with impact damage. The compressor also rotated freely.

The fuel filter for each engine and the two electric boost pumps for the left main tank were tested. Both fuel filters met the test specification of a maximum pressure drop of 0.4 psi at 500 gallons per hour (gph) and no anomalies were noticed at flow rates up to 1,000 gph. Both electric boost pumps operated normally and met test specifications.

The left engine torque pressure transducer was tested; the transducer met test specifications at torque values ranging from 0 to 80 psi, with no anomalies noted.

The auto-feather oil dump solenoid and speed reset solenoid from the left engine propeller overspeed governor were tested; both solenoids met test specifications, with no anomalies noted.

Medical and Pathological Information

The Office of the Coroner, Stark County, Ohio, conducted an autopsy on both pilots. The cause of death for both was blunt force injury.

Toxicology testing performed on the captain by the Federal Aviation Administration's (FAA) Forensic Sciences Laboratory on specimens collected after embalming identified methanol in urine. Methanol is a common ingredient in embalming fluid.

Toxicology testing performed on the first officer by the FAA on specimens collected after embalming identified atorvastatin, naproxen, and diphenhydramine and methanol in urine. Blood testing was negative for diphenhydramine.

Atorvastatin is a medication for cholesterol control and cardiovascular disease prevention and naproxen is an anti-inflammatory medication used for control of pain and fever. Neither of these medications are considered impairing. Diphenhydramine is a sedating antihistamine available over the counter in cold, allergy, and sleep aid products and can cause cognitive and psychomotor slowing and drowsiness.

Additional Information

Minimum Control Airspeed Issues

In order to maintain directional control with an engine inoperative, the airplane's minimum control airspeed (Vmc) must be maintained. According to an FAA test pilot, Vmc was to be reevaluated for the accident airplane by flight test as a part of the certification for installing engines with a higher horsepower. Vmc for the airplane with the previously approved engines was 67 knots indicated airspeed. Based on similar certification projects, Vmc was expected to increase about 5 to 6 knots with the higher horsepower engines.

During the accident, with the left engine power loss and propeller not feathered, drag equations estimated a Vmc increase of 20 knots. The airplane's yaw and bank to the left was estimated to increase Vmc 5 to 10 knots. Based on these estimations, the minimum airspeed required to maintain lateral control during the accident sequence was about 97 to 107 knots. According to ADAS data, the airspeed at engine failure was about 86 knots and reached a maximum of about 91 knots.

Engine Failure During Takeoff Procedure

The flight manual procedure for an engine failure during takeoff is shown in Figure 2. Immediate action/memory items are in bold print.

ENGINE FAILURE DURING TAKEOFF
(After V_1 Continue)

Airspeed .... **V_2 UNTIL CLEAR OF OBS.**
Directional Control .... **MAINTAIN: 5° BANK TOWARD GOOD ENGINE**
Power (Opr Eng) .... **MAXIMUM**
Gear .... **RETRACT**
Prop (Inop Eng) .... **FEATHER**
Trim .... AS REQUIRED
Climb ....STRAIGHT AHEAD TO SAFE ALT.
Inop Engine ....COMPLETE ENG. SECURE PROCEDURES

Figure 2 – Engine Failure During Takeoff Procedure

Startle Effect / Reaction Time Discussion

Pilot response time to an unexpected event can vary as it encompasses both the time required to detect the event, identify the correct response, and initiate its implementation. Response times to unalerted events can take up to 3-4 seconds.

Administrative Information

Investigator In Charge (IIC):	Folkerts, Michael
Additional Participating Persons:	Jose Borges; Flight Standard District Office; North Olmsted, OH Patrick Hempen; Federal Aviation Administration - AVP-100; Washington, DC Dennis Stauffer; AFM Hardware Inc.; Kidron, OH Harald Reichel; National Transportation Safety Board; Washington, DC Helen Tsai; Transportation Safety Board - Canada; Ottawa Thomas Karge; German Federal Bureau of Aircraft Accident Investi; Braunschweig
Original Publish Date:	September 23, 2020
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=98847