Aviation Investigation Final Report

Location:	Oceanside, California	**Accident Number:**	WPR22LA114
Date & Time:	February 24, 2022, 12:45 Local	**Registration:**	N10JA
Aircraft:	Cessna 208B	**Aircraft Damage:**	Substantial
Defining Event:	Collision with terr/obj (non-CFIT)	**Injuries:**	2 Serious
Flight Conducted Under:	Part 91: General aviation - Skydiving		

Analysis

The pilot was performing skydiving operations in the turboprop-equipped airplane. During the fourth flight of the day, after the skydivers departed the airplane, the pilot initiated a steep, turning descent with the power at idle, during which the airplane reached a maximum descent rate of 6,400 ft per min (fpm). While the airplane was on the base leg of the traffic pattern, the pilot attempted to arrest the descent by adding power; however, the engine did not respond to his movements of the power lever. He moved the propeller speed lever, which was also had no effect. He applied full nose-up trim and pulled the control yoke full aft against the stop, but the airplane would not maintain a level attitude, and subsequently collided with terrain short of the runway in a nose-low attitude.

There were numerous publications from the STC holder and the engine and propeller manufacturers warning pilots to not use beta mode during inflight operations unless it is certified for those operations. If the power lever is placed below the flight idle gate into beta mode while inflight, the blade position will move to a fine blade angle. Depending on propeller rpm and flight speed, this adjustment may cause the moment from the aerodynamic load on the blade to shift from coarsening to fining, and may result in the propeller blades entering reverse and remaining “aerodynamically locked” in that position. No power lever input from the pilot can alter this, and using the feather valve is ineffective. It is likely that the only viable option to unlock the propeller is to shut down the engine to reduce the moments locking the propeller in place, given it could overcome windmilling speed loads on the blades.

Postaccident examinations revealed no evidence of a mechanical malfunction with the engine, propeller, or airframe. A bench-flow test and subsequent teardown examination of the propeller governor revealed a few test points outside of limits that would not have precluded normal governor operation. The propeller rigging was incorrect and it is unknown if the rigging was changed on purpose to aid with faster descent rates; if this was the rigging at the time of the accident flight, it would have contributed to entering an aerodynamic lock sooner.

A performance study of the flight based on Automatic Dependent Surveillance – Broadcast (ADS-B) data revealed high negative thrust values that can only be achieved with the power lever below the flight idle gate. It is likely that the propeller blade pitch angle was in beta and that the aerodynamic moment on the blades had reversed, locking the propeller in place and preventing the pilot from recovering control of the propeller.

Probable Cause and Findings

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

The pilot’s intentional inflight operation of the propeller in beta, which led to an aerodynamic lock, his inability to restore forward thrust, and subsequent collision with terrain.

Findings

Aircraft	Propeller feather/reversing - Incorrect use/operation
Personnel issues	Incorrect action selection - Pilot

Factual Information

History of Flight

Approach	Collision with terr/obj (non-CFIT) (Defining event)

On February 24, 2022, at 1245, a Cessna C208B Supervan 900 airplane, N10JA, was substantially damaged when it was involved in an accident in Oceanside, California. The pilot and passenger were seriously injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 skydiving flight.

The pilot stated that the pilot-rated passenger was spending the day observing the skydiving operation. He had made three consecutive flights climbing to around 13,000 feet mean sea level (msl) to unload the skydivers. On the fourth flight, the pilot departed runway 25 and made a gradual climb to 12,700 ft msl as he circled back to the airport. The skydivers departed the airplane and the pilot initiated a steep, turning descent with the power at idle. He stated that the airplane was in "beta mode" but that the power lever was above the flight idle gate and the speed lever was left in the high position. The pilot stated that, while the airplane was on the base leg of the traffic pattern to runway 25, at an altitude about 4,000 ft msl and a descent rate of 4,500 fpm, he attempted to arrest the descent by adding power.

The pilot further stated that despite his attempt to add power, the engine did not respond to movements of the power lever. He moved the propeller speed lever, which also had no effect. The pilot presumed that the engine had flamed out and attempted a restart. With the propeller still windmilling, he switched the ignition to "continuous" and turned the boost pump on. He observed the torque gauge increase from 0% to 20%, but the engine was still unresponsive to movements of the power lever. He applied full nose-up trim and pulled the control yoke full aft against the stop, but the airplane would not maintain a level attitude. With the airplane in a nose-low attitude, it collided with terrain about 1,400 ft short of the runway (see Figures 1 and 2 below). The pilot did not feather the propeller.

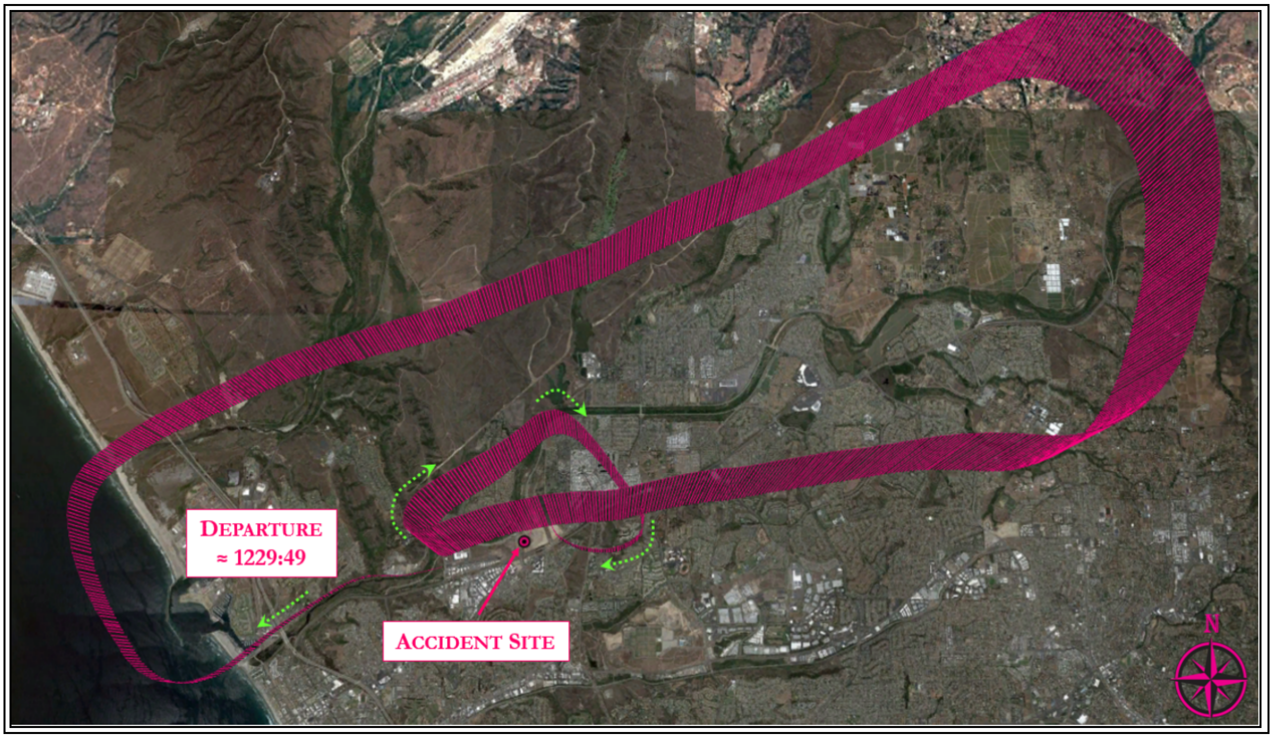

Figure 1: Flight Path on Accident Flight

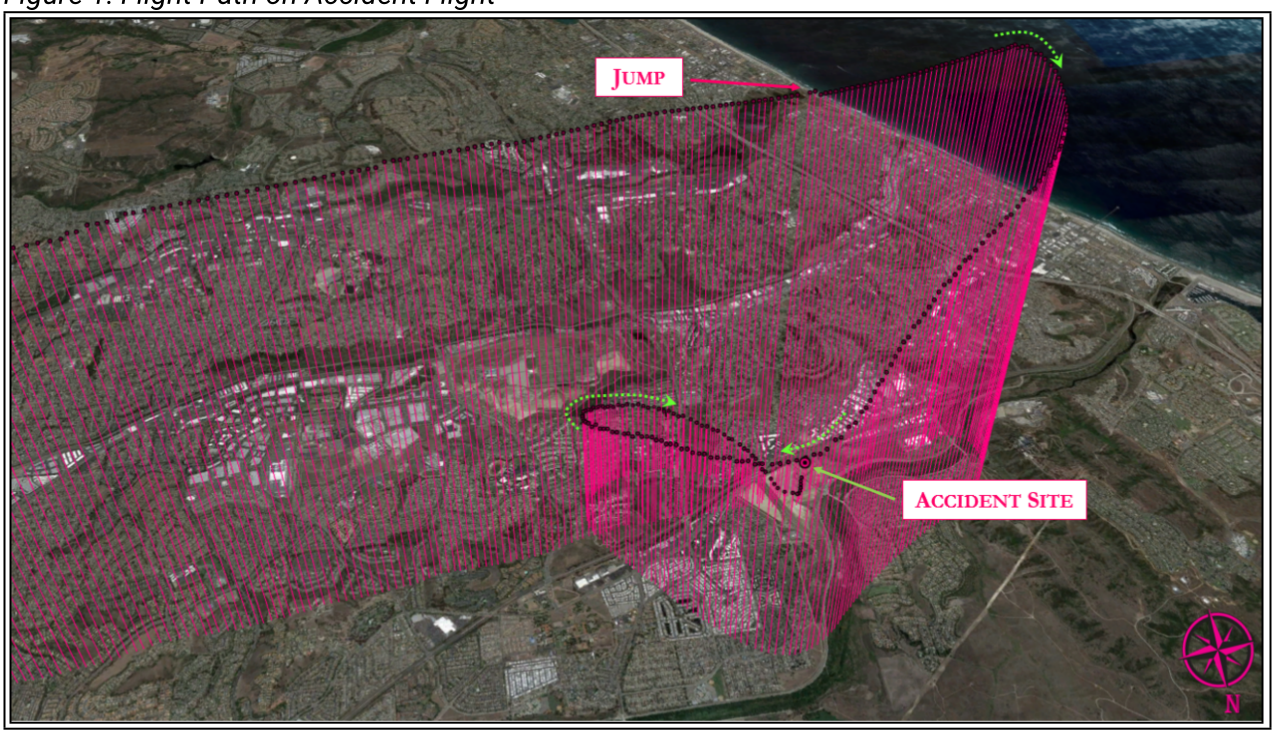

Figure 2: Flight Path during Descent

The pilot-rated passenger stated that the pilot told him that during the skydiving operations they sometimes used a "beta" setting in flight. The pilot said that they would use beta to descend and race the skydivers to the ground. On the accident flight, after the skydivers were dropped, the pilot began a steep descent and retarded the thrust lever into beta. The fuel gauges showed zero, indicating that the fuel tanks were empty. The passenger notified the pilotof the fuel situation, and the pilot stated that the gauges were inaccurate. While on the base leg of the traffic pattern, he thought that the airplane was high and fast. The pilot stated that he was going to make a right turn without using any rudder.

The passenger further stated that the pilot initiated a steep right turn for a few seconds and then a steep left turn. He recalled that the turns were all uncoordinated and the auxiliary fuel pump light was illuminated. The pilot began to move the power and propeller speed levers and stated that they "lost the engine." The airplane impacted terrain in a nose-low attitude. The passenger took several videos of the accident and previous flights from his cell phone. The clip from the accident flight showed that the fuel gauges indicated empty, the propeller rpm was about 65%, and the oil temperature and pressure gauges were in the green arcs (normal range).

ADS-B information indicated that the airplane reached a maximum rate of descent of about 6,400 fpm shortly after entering the descent, and was descending around 5,300 fpm descent while turning from the base leg to final approach about 3,350 ft above ground level.

Pilot Information

Certificate:	Airline transport	**Age:**	47,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	**Toxicology Performed:**	
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	February 15, 2022
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	April 3, 2021
Flight Time:	4516 hours (Total, all aircraft), 246 hours (Total, this make and model), 3315 hours (Pilot In Command, all aircraft), 243 hours (Last 90 days, all aircraft), 94 hours (Last 30 days, all aircraft), 3 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Cessna	**Registration:**	N10JA
Model/Series:	208B Supervan	**Aircraft Category:**	Airplane
Year of Manufacture:	2002	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	208B0961
Landing Gear Type:	Tricycle	**Seats:**	
Date/Type of Last Inspection:	February 16, 2022 100 hour	**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	1 Turbo prop
Airframe Total Time:	9568 Hrs at time of accident	**Engine Manufacturer:**	Honeywell
ELT:	Installed	**Engine Model/Series:**	TPE331-12JR
Registered Owner:	GOSKY AMERICA 5 INC	**Rated Power:**	
Operator:	GoJump	**Operating Certificate(s) Held:**	None

The airplane was modified in 2020 by the Supervan Systems, Ltd. (Texas Turbines) TPE331 engine installation Supplemental Type Certificate (STC) SA10841SC and composite 4-blade propeller installation by BS Designs Inc. STC SA09872AC.

The airplane's engine is managed by the pilot through the power lever and speed lever located in the cockpit center console. The engine power lever (black) connects to the propeller pitch control and the manual fuel valve. The engine speed lever (blue) connects to the propeller governor and to the underspeed fuel governor (USFG).

The propeller control system is designed to operate in either propeller governing range or beta range. When the engine power lever is forward of the flight idle gate, the engine is in the propeller governing mode. As airspeed decays, the propeller governor outputs higher oil pressure until "beta pressure" is available, turning on the beta light in the cockpit. The presence of beta pressure enables the engine to operate in the beta range once the power lever is pulled aft of the flight idle gate. The gate is a mechanical detent in the engine control console that prevents inadvertent reduction of the power lever below the flight idle setting. Before the power lever can be reduced below the flight idle setting, the pilot must lift a silver T-handle located under the power lever over the detent gate/lock, which allows the power lever to be moved further aft.

In the propeller governing range, the power lever controls the engine power by adjusting the fuel flow from the manual fuel valve. Engine rpm is selected using the speed lever, which varies the propeller blade angle using the propeller governor. In the beta range, the power lever varies the propeller blade angle using the propeller pitch control. To maintain the speed lever and engine rpm settings, the USFG varies the engine power by scheduling the fuel flow. The USFG controls the engine rpm settings between 68% and 96%.

Propeller Operation

The Honeywell TPE331 turboprop engine was equipped with a Hartzell Lightweight Turbine Series, 4-bladed, single-acting, hydraulically operated constant-speed model propeller with feathering and reverse pitch capability. The propeller features an aluminum hub and composite blades. The propeller pitch is adjusted by using engine oil pressure to displace an internal piston axially along the propeller assembly. Pitch change knobs connecting the piston movement to each blade root cause changes in blade pitch angle with any axial movement of the piston. Oil pressure from the propeller control system exerts force on only one side of a piston, leading to a reduction (or fine adjustment) in the propeller blade pitch angle. Conversely, oil pressure cannot drive the blades in the coarse direction. A feather spring situated on the opposing side of the piston continually drives the propeller blade pitch toward the feather position (or coarse adjustment). Counterweights on each blade also provide a twisting moment toward the feather position. The feather position represents the maximum coarse position of the blades.

During operation at flight idle or above and with sufficient airspeed, the propeller governor (PG) automatically regulates the propeller blade pitch angle based on engine speed and power requirements. The propeller pitch control (PPC) unit is inactive during this flight mode. The engine propeller controls ensure that the propeller blade angle remains above the established safe in-flight minimum blade low-pitch angle, which is set at the time of installation to 5.5°.

In the beta mode, the PPC takes over controlling the propeller blade pitch angle, and any movement of the power lever by the pilot directly adjusts the propeller blade angle. The PG is not controlling the blade angle in this mode; however, it is still supplying high-pressure oil to the PPC. The high-pressure oil is what triggers the beta light. Beta mode permits the blade angle to decrease below the safe in-flight minimum blade low-pitch angle.

During normal flight conditions, when the power lever is at flight idle or above, the combination of inherent moments on blades always acts in the coarsening or feathering direction, allowing the PG oil pressure to fine-tune the blade position until a propeller rpm of 100% is achieved.

However, if the power lever is placed below flight idle into beta mode during flight, the blade position will move to a fine blade angle. Depending on propeller rpm and flight speed, this adjustment may cause the moment from the aerodynamic load on the blade to shift from coarsening to fining. Eventually, the sum of the fining moments can exceed the sum of the coarsening moments, causing the blade to enter reverse and remain “aerodynamically locked” in that position. No power lever input from the pilot can alter this and using the feather valve is ineffective because the dome pressure is already at zero.

A pressure switch in the propeller control system is used to power an indicator light in the cockpit. The light is illuminated when the propellor governor is supplying max output pressure (beta pressure) and the pilot has the ability to control the propeller blade angle using beta mode.

Fuel

The Federal Aviation Administration (FAA) inspectors who responded to the accident stated that the fuel tanks remained intact with no apparent perforations. Recovery personnel drained about 20 gallons of fuel from the airplane, all of which was in the right wing (the airplane came to rest in a right-wing-low attitude).

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KOKB,28 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	12:52 Local	**Direction from Accident Site:**	286°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	11 knots /	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:	260°	**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	30.22 inches Hg	**Temperature/Dew Point:**	16°C / -3°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Oceanside, CA	**Type of Flight Plan Filed:**	None
Destination:	Oceanside, CA	**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	Class D

Airport Information

Airport:	Bob Maxwell Memorial Airfield OKB	**Runway Surface Type:**	Asphalt
Airport Elevation:	28 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	25	**IFR Approach:**	None
Runway Length/Width:	2712 ft / 75 ft	**VFR Approach/Landing:**	Traffic pattern

Wreckage and Impact Information

Crew Injuries:	1 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Serious	**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	2 Serious	**Latitude, Longitude:**	33.220357,-117.34318(est)

A teardown examination of the engine revealed no evidence of mechanical failure or malfunction that would have precluded normal operation. There was metal spray found throughout the engine and several impeller blades bent in the opposite direction of rotation, consistent with the engine rotating, fuel flowing through the fuel nozzles, and flame in the combustor at the time of impact.

A bench flow-test and subsequent teardown examination of the fuel control unit revealed no evidence of malfunction; there were trace amounts of an unidentifiable blue debris found in the screen. A bench-flow test and subsequent teardown examination of the propeller governor revealed a few test points outside of limits.

The propeller remained attached to the engine propeller shaft flange, with all four blades fractured at the shank. Three blades were fully recovered and the tip fragment of the fourth blade was with the wreckage; the entirety of that blade was not recovered. Blade Nos. 3 and 4 counterweights were rotated beyond the mechanical reverse stop, indicating damage to pitch change components. Chordwise/rotational scoring was evident on blade Nos. 3 and No. 4, similar to blade No. 1. The propeller hydraulic unit appeared undamaged, with one start lock pin fractured. The hub unit showed no visible fractures, but rotational scoring marks were observed. All four blades displayed leading edge nicks and trailing edge compression delamination. Counting the turns when removing the beta tube revealed that the rigging was equivalent to about 3.7° rather than 5°. Review of maintenance records revealed no entries related to propeller rigging, and it could not be determined if the rigging was adjusted following installation.

The propeller manufacturer stated that all visible damage was consistent with impact while turning under low power at a low blade angle while creating drag; the propeller was not feathered. All damage was consistent with high impact forces. There were no visible anomalies on the propeller components that would have prevented normal operation.

Tests and Research

Performance Study

The Safety Board Vehicle Performance division performed a study of the engine thrust during the accident descent. Comparisons were made between the thrust coefficients of the accident descent, the two preceding descents, and descents flown in other Supervans at known power settings. ADS-B data for these flights included time, ground speed, true and calibrated airspeeds, vertical speed, and track angle information. Using this data, the thrust required during each descent was determined based on the altitude and speed profiles of the descent and on the airplane's nominal drag characteristics.

The results revealed that the negative thrust levels required during the accident descent and the two previous descents were significantly higher than those required during descents with a different aircraft for which the power lever is known to have been set at flight idle. The study determined that, during the accident descent, the thrust did not increase following the pilot's advancement of the power lever. It is likely that the propeller blade pitch angle was finer than 5.5° and that the aerodynamic moment on the blades had reversed, locking the propeller in place and preventing the pilot from recovering control of the propeller. According to Hartzell, such high negative thrust values can only be achieved with the power lever below the flight idle gate.

Additional Information

Video

The passenger recorded several videos during the flights on the day of the accident. A video taken about two minutes before the accident showed the rpm at 64%. The annunciator panel was not visible. In addition, a 12-second video was taken on the flight before the accident flight. This video started at 1206 and was consistent with being taken after the skydivers had jumped out and the airplane was in a descent. During that video, the annunciator panel can briefly be seen with the “right fuel-low” and “beta” light illuminated. That video additionally showed a reflection of the throttle quadrant in a mirror mounted on the instrument panel. The position of the power lever and condition lever could not be definitively determined, but they appeared to be together (not split), indicating that the speed lever was not in a high setting.

Operations

Skydiving airplane operators have been known to use beta mode in flight, incentivized by the nature of their operations, which typically involve frequent take-offs, rapid ascents to a predetermined altitude, and swift descents to facilitate quick turnarounds for subsequent loads of skydivers. In this context, beta mode enables pilots to expedite the descent and minimize the time spent in transit between jumps.
In communications with the NTSB, Texas Turbines representatives stated that “beta mode” can occur (with the “beta” light illuminating) with the power lever forward of the flight idle gate, if the airspeed is approximately 80 knots or slower. Hartzell (the propeller manufacturer) defines “beta mode” as the condition when the propeller pitch angle is finer than 5.5°, which can only occur when the power lever is aft of the flight idle gate. The Texas Turbines representative further stated that “hundreds of pilots have done BETA descents with the airplanes for tens of thousands of hours with the Supervans with no issues as long as they have not transitioned below the flight idle gate.” Honeywell defines “beta mode” as when the power lever is behind the flight idle gate, where the propeller pitch control is controlling blade angle.

The beta light illuminating in flight is not synonymous with the engine being in “beta mode.” In propeller governing mode, the beta light indicates that the propeller governor has sensed an underspeed condition and is providing maximum oil pressure (referred to as beta pressure) to the propeller dome. Due to the positioning of the beta tube in the propeller pitch control, the propeller governor cannot fine the propeller blades below the flight idle blade angle. The underspeed governor then controls engine/propeller speed by modulating the fuel flow.

The flight idle gate is the physical stop in the pedestal to prevent reducing the power lever into the beta mode range, where the propeller pitch control commands a blade angle lower than the flight idle blade angle; hence, the importance of not reducing the power lever position beyond the flight idle gate in flight.

The Supervan Airplane Flight Manual Supplement states:

Beta Mode is the engine operational mode in which propeller blade pitch is controlled by the power lever. A beta light can illuminate during landing under some conditions, but [beta mode] is not normally used during flight. Operation below the flight idle gate is prohibited in flight.

The Supervan Instructions for Continued Airworthiness states:

During low airspeed operation, the propeller governor is locked out (beta mode) and the prop pitch control is used to select the required propeller blade angle thru power lever movement…When the engine is operating in the beta control range, engine power is adjusted by the underspeed governor in the FCU.

Hartzell states that the use of beta mode during flight (defined as the propeller pitch angle being finer than 5.5° as a result of the power lever placed aft of the flight idle gate) can have disastrous consequences and that under certain conditions using beta mode in flight can result in a dangerous and irreversible situation at low speed and/or low altitude.

The Honeywell TPE331 Pilot Tips publication gives a warning that "IN-FLIGHT BETA-MODE (PL BEHIND FI) IS PROHIBITED," with the disclaimer "unless the airplane is certified for In-Flight Beta-Mode." This warning implies that the airplane won't be in beta mode as long as the power lever is forward of the flight idle gate, which is not correct in the Supervan 900. It added that some TPE331-equipped single-engine airplanes are certified for "in-flight BETA for high rates of descent at low airspeed," and directs the user to consult the flight manual or pilot operating manual."

The publication further states:

The use of beta-mode in-flight is prohibited due to the risk associated with placing power levers below the FI gate, which sets propeller blades at angles not certified for in-flight conditions. Doing so creates high drag, causing excessive airspeed deceleration and potentially inducing an uncontrollable roll rate due to asymmetric thrust and drag. Additionally, it may obstruct elevator airflow, hampering stall avoidance and recovery efforts.

Honeywell issued a Pilot Advisory Letter in October 2001 cautioning pilots against using Beta Mode while in flight and states the risk of placing the power lever behind the flight-idle gate resulting in the obstruction of elevator airflow. It clarified that "If the PL is pulled below flight idle while at in-flight airspeeds, an abrupt decrease in blade angle and sudden increase in propeller drag may occur."

Administrative Information

Investigator In Charge (IIC):	Keliher, Zoe
Additional Participating Persons:	Oded Moore; Federal Aviation Administration; San Diego, CA Les Doud; Hartzell Propellers; Piqua, OH Ricardo Asensio; Textron Aviation ; Wichita, KS Bobby Bishop; Texas Turbine Conversions; TX Jennifer McDuffie; Honeywell Aerospace; Phoenix, AZ
Original Publish Date:	May 16, 2024
Last Revision Date:	
Investigation Class:	Class 3
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=104712