Aviation Investigation Final Report

Location:	California City, California	**Accident Number:**	DCA23LA340
Date & Time:	June 29, 2023, 08:05 Local	**Registration:**	N283TD
Aircraft:	SUPERNAL LLC SUP83-1	**Aircraft Damage:**	Substantial
Defining Event:	Loss of control in flight	**Injuries:**	N/A
Flight Conducted Under:	Part 107: Small UAS		

Analysis

On June 29, 2023, at 0805 Pacific daylight time (PDT), a Supernal, LLC., SUP83-1 unmanned aircraft system, N283TD, received substantial damage during a developmental test flight at the manufacturer's test site. There were no injuries. The aircraft was operating with an FAA Certificate of Waiver (COA) 2022-WSA-213-SAC-REV1, under Exemption No. 20050 Regulatory Docket No. FAA-2022-1757.

According to the operator/manufacturer, the test flights were intended to expand the aircraft's flight envelope from the previously expanded forward speed envelope of 8 ft/sec to 20 ft/sec.

At the beginning of the flight test, hover checks were performed. The first hover was very stable, and during the second hover there were some oscillations that were not present during the first hover. In the second hover, while landing, the aircraft did not detect the ground and the rotors continued rotating and the aircraft oscillated a little. The crew-chief/observer then manually cycled the avionics power by removing the power jumper connector on front of aircraft and reinserted it to reboot the system, after which the GPS and telemetry were noted to be stable.

The crew then proceeded to execute the steps for forward flight, and the aircraft remained in GPS fixed mode as it climbed to 20 ft above ground level (AGL) in a stabilized hover test. After the hover test and systems check, the decision was made to continue the test flight, so the pilot in command (PIC) turned the aircraft to the outbound heading and accelerated it.

Upon reaching an acceleration of 9 ft/second the right inceptor, used to control the aircraft about its three axes, was then moved to the detent to capture the 12 ft/sec data point. The aircraft accelerated through the 12 ft/sec targeted velocity data point to the 16 ft/sec data point, at which time the PIC then pulled back inceptor to reduce the speed to the 12 ft/sec data

point. During the acceleration and deceleration of the vehicle there were good stable responses to control inputs.

The inceptor was then pulled back to achieve maximum deceleration to bring the aircraft to a stop, and the aircraft responded normally, stopping its forward velocity. The inceptor was then moved to the detent to enter the hover position, at which point all power was lost and all rotors stopped turning and the aircraft fell to the ground from a height of about 20 ft AGL.

Upon impact with the ground the aircraft bounced and came to rest upside down. There was damage to the landing gear, fuselage, wingtip nacelles, wing booms, tailbooms, and empennage.

The accident aircraft, a SUP83-1 unmanned aircraft system, serial number 002, manufactured in 2023, registered to TVPX Aircraft Solutions Inc., and operated by Supernal LLC., as a 25% subscale unmanned test aircraft used to research distributed electric propulsion technologies. The aircraft has six propulsors driven by electric motors that are powered by lithium-ion battery packs. The aircraft can perform vertical take-offs and landings and can be reconfigured to horizontal flight with lift being generated by its wings. The aircraft is controlled from a handheld transmitter by a remote pilot and monitored by a PC laptop ground station linked to the aircraft via telemetry radios inside a mobile trailer at the test site. At the time of the accident the aircraft had accumulated about 1.9 hours.

The pilot was an FAA certified private airplane pilot, and reported 560 hours total flight experience, of which about 1 hour was with the accident aircraft. The test flight was also supported by a visual observer who was stationed near the pilot and one team member who was located inside the ground control station. The pilot, visual observer, and ground control station operator used hands free headsets to maintain communication during the entire event, and there were no communication difficulties.

The test site for this aircraft is a privately owned area near California City, California, within the Hyundai Motor Group's California Proving Grounds automotive testing facility. Surrounded by unimproved desert, the test area has a large, paved ramp area from which operations are conducted along with the supporting infrastructure appropriate for the operations of the site. Per COA, SUP 83-1 was permitted to fly within its test area up to 400' AGL, remaining clear of both Mojave Air & Spaceport/Rutan Field Airport's (MHV's) controlled airspace, and the Edwards Air Force Base's Restricted Area 2515.

Weather was not a factor in the accident. At 0600 PDT the weather at MHV, located 6 miles from the test site, was reported as sky clear with winds variable at 2 kts, visibility 10 statute miles, and temperature 82 degrees.

The operator/developer's post-accident examination revealed that there was erroneous signal processing of commands from the handheld transmitter. The erroneous signal processing caused the high-voltage contactor on the vehicle to open, resulting in a total loss of propulsion

power. Further analysis of the software and hardware revealed that the contactor command from the handheld transmitter was not filtered, which resulted in short-duration signal noise being unimpeded.

Probable Cause and Findings

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

Erroneous signal processing that resulted in a total loss of propulsion power.

Findings

Aircraft	(general) - Malfunction

Factual Information

History of Flight

Maneuvering	Loss of control in flight (Defining event)

Pilot Information

Certificate:	Private	**Age:**	55
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	None
Other Aircraft Rating(s):	Unmanned (sUAS)	**Restraint Used:**	None
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	November 18, 2021
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	December 21, 2022
Flight Time:	560 hours (Total, all aircraft), 1 hours (Total, this make and model), 517 hours (Pilot In Command, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	SUPERNAL LLC	**Registration:**	N283TD
Model/Series:	SUP83-1	**Aircraft Category:**	Powered-lift
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Unknown	**Serial Number:**	002
Landing Gear Type:	Tricycle	**Seats:**	0
Date/Type of Last Inspection:	June 28, 2023 Condition	**Certified Max Gross Wt.:**	150 lbs
Time Since Last Inspection:		**Engines:**	6 Electric
Airframe Total Time:	1.93 Hrs	**Engine Manufacturer:**	T-Motor
ELT:		**Engine Model/Series:**	U13II KV130
Registered Owner:	TVPX AIRCRAFT SOLUTIONS INC TRUSTEE	**Rated Power:**	24 Lbs thrust
Operator:	Supernal LLC	**Operating Certificate(s) Held:**	Certificate of authorization or waiver (COA)

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KMHV,2802 ft msl	**Distance from Accident Site:**	6 Nautical Miles
Observation Time:	06:00 Local	**Direction from Accident Site:**	269°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	2 knots /	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:		**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:		**Temperature/Dew Point:**	27.8°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	California City, CA	**Type of Flight Plan Filed:**	None
Destination:	California City, CA	**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	N/A	**Aircraft Damage:**	Substantial
Passenger Injuries:	N/A	**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	N/A	**Latitude, Longitude:**	35.081667,-118.09388

Administrative Information

Investigator In Charge (IIC):	Lovell, John
Additional Participating Persons:	John Illson, Safety officer; TVPX Aircraft Solutions Pat Hempin; FAA; Washington , DC
Original Publish Date:	July 10, 2024
Last Revision Date:	
Investigation Class:	Class 4
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=192490