



Aviation Investigation Final Report

Location:	Reno, Nevada	Accident Number:	WPR22FA350
Date & Time:	September 18, 2022, 15:44 Local	Registration:	N129MM
Aircraft:	AEROVODOCHODY L-29 DELFIN	Aircraft Damage:	Destroyed
Defining Event:	Loss of control in flight	Injuries:	1 Fatal
Flight Conducted Under:	Part 91: General aviation - Air race/show		

Analysis

The pilot of the accident airplane was participating in a closed-course air race and was varying between first and second place. During the 3rd lap of 6, the accident airplane began a climb as it neared outer pylon No. 4, where it appeared to tighten its left turn toward the inner portion of the racecourse. At the peak of the climb, the airplane entered an approximate 90° right bank and started a descent before it rolled left to an approximate 90° left bank. The airplane continued to descend in a steep left bank and nose-low attitude until it impacted terrain just beyond outer pylon No. 5.

Postaccident examination of the airplane revealed no evidence of any preexisting mechanical malfunction that would have precluded normal operation.

As the airplane rolled 90° right and pitched up, followed by a 180° left roll and descent, the pilot’s lack of control inputs following the roll indicated that the pilot likely experienced an onset of higher G loads during the left roll, which ultimately led to G-induced loss of consciousness (G-LOC). The reason for the pilot’s initial roll to the right is unknown; however, it’s likely that the pilot’s aggressive roll to the left was an effort to maintain his position in the race. It is possible that the pilot’s coronary artery disease and/or amlodipine use may have reduced his G-tolerance; however, the investigation was unable to determine if the pilot’s medical conditions or medication use contributed to the accident.

Probable Cause and Findings

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

The pilot's in-flight incapacitation due to G-induced loss of consciousness, which resulted in a subsequent impact with terrain.

Findings

Personnel issues

Other loss of consciousness - Pilot

Factual Information

History of Flight

Maneuvering-low-alt flying	Loss of control in flight (Defining event)
Maneuvering-low-alt flying	Collision with terr/obj (non-CFIT)

On September 18, 2022, about 1544 Pacific daylight time, a Aerovodochody L29-Delphin, N129MM, was destroyed when it was involved in an accident near Reno, Nevada. The pilot was fatally injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 91 air race flight.

The pilot of the accident airplane, who was operating as Race 29, was on lap 3 of 6, and was varying between first and second place with Race 77, another L-29. Witnesses reported that the accident airplane began a climb as it neared outer pylon No. 4, where it appeared to tighten its left turn toward the inner portion of the racecourse. At the peak of the climb, the airplane entered an approximate 90° right bank and started a descent before it rolled left to an approximate 90° bank. The airplane continued to descend in a steep left bank and nose-low attitude until it impacted terrain just beyond outer pylon No. 5.

Recorded video captured the accident sequence from various locations. The camera located south of the racecourse's home pylon showed the accident airplane flying a path that appeared to be inside of and lower than Race 77. The accident airplane began a climb while in a left bank, and at the peak of the climb the airplane rolled right to a 90° right bank attitude along with a slight nose-down attitude. The roll was immediately followed by a roll to the left. During the roll to the left, the nose of the airplane entered a slight nose-up attitude; however, as the angle of bank increased, the nose of the airplane entered a nose-low attitude. The left roll stopped as the airplane was in an approximate 90° left bank, nose-low attitude. The airplane continued to descend in a steep left bank and nose-low attitude until it impacted terrain where a post-impact fire ensued.

A second camera, located near outer pylon No. 4, captured Race 77 and Race 29 along with 2 additional airplanes behind their position. Race 29 appeared to be inside of Race 77 in about a 90° left bank on a trajectory towards the location of where the video was filmed from. Race 29 began a right roll to about a 90° right bank and passed behind Race 77. Race 29 subsequently rolled to the left, and as it reached about 90°, the nose appeared to pitch downward slightly, and the airplane continued to descend in a steep left bank until it traveled behind a tree.

The pilot of Race 77 reported that the accident pilot appeared to be flying an extremely tight line, and his turns around the pylons were "sharp, with heavy loading." Another jet-class pilot reported that during the race week, they did not fly all of the races that week due to the weather

and restricted visibility conditions. He stated that he thought that if the accident pilot would have had more time on the racecourse at the speeds he was flying during the accident race, the pilot “may have been better prepared psychologically for the race.”

A photograph (Figure 1) that was captured by a witness just before impact showed that all primary flight controls remained attached to the airframe at the time of the accident.



Figure 1: Photo taken just before impact with the terrain.

Pilot Information

Certificate:	Private	Age:	61, Male
Airplane Rating(s):	Single-engine land	Seat Occupied:	Front
Other Aircraft Rating(s):	None	Restraint Used:	5-point
Instrument Rating(s):	Airplane	Second Pilot Present:	No
Instructor Rating(s):	Instrument airplane	Toxicology Performed:	Yes
Medical Certification:	Class 2 With waivers/limitations	Last FAA Medical Exam:	June 14, 2022
Occupational Pilot:	No	Last Flight Review or Equivalent:	June 15, 2021
Flight Time:	(Estimated) 2431 hours (Total, all aircraft), 78 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	AEROVODOCHODY	Registration:	N129MM
Model/Series:	L-29 DELFIN	Aircraft Category:	Airplane
Year of Manufacture:	1968	Amateur Built:	
Airworthiness Certificate:	Experimental (Special)	Serial Number:	892790
Landing Gear Type:	Tricycle	Seats:	2
Date/Type of Last Inspection:	March 12, 2022 Condition	Certified Max Gross Wt.:	
Time Since Last Inspection:		Engines:	1 Turbo jet
Airframe Total Time:	3483 Hrs as of last inspection	Engine Manufacturer:	P & W
ELT:		Engine Model/Series:	JT12A-6
Registered Owner:	On file	Rated Power:	3000 Lbs thrust
Operator:	On file	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:	KRTS,5053 ft msl	Distance from Accident Site:	2 Nautical Miles
Observation Time:	03:55 Local	Direction from Accident Site:	173°
Lowest Cloud Condition:	Scattered / 7500 ft AGL	Visibility	10 miles
Lowest Ceiling:	Broken / 12000 ft AGL	Visibility (RVR):	
Wind Speed/Gusts:	4 knots /	Turbulence Type Forecast/Actual:	None / None
Wind Direction:	40°	Turbulence Severity Forecast/Actual:	N/A / Severe
Altimeter Setting:	29.74 inches Hg	Temperature/Dew Point:	12°C / -5°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Reno, NV	Type of Flight Plan Filed:	None
Destination:	Reno, NV	Type of Clearance:	None
Departure Time:		Type of Airspace:	Class G

Airport Information

Airport:	RENO/STEAD RTS	Runway Surface Type:	
Airport Elevation:	5050 ft msl	Runway Surface Condition:	Dry
Runway Used:		IFR Approach:	None
Runway Length/Width:		VFR Approach/Landing:	None

The closed racecourse design for the National Championship Air Races (NCAR) jet class featured 10 pylons (plus 2 guide pylons), and the course distance was about 8.4 miles.

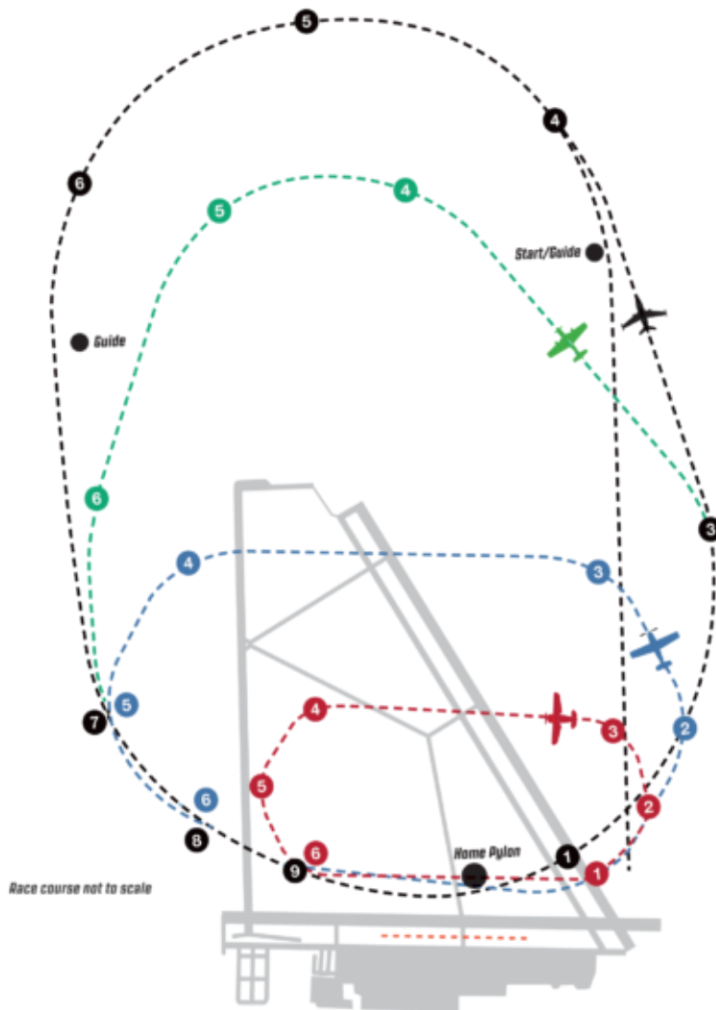


Figure 2: Reno NCAR closed racecourse layout. Jet course is outlined in black. (Image courtesy of airrace.org) Map not to scale.

Wreckage and Impact Information

Crew Injuries:	1 Fatal	Aircraft Damage:	Destroyed
Passenger Injuries:		Aircraft Fire:	On-ground
Ground Injuries:	N/A	Aircraft Explosion:	On-ground
Total Injuries:	1 Fatal	Latitude, Longitude:	39.708298,-119.88266

Examination of the accident site revealed that the airplane impacted terrain on a heading of about 229° magnetic. The first identified point of contact (FIPC) with terrain was a swath of freshly disturbed dirt, consistent with a left-wing impact. The swath of disturbed dirt continued for about 180 ft to a large burn area. The 2,200-ft-long debris path continued along a heading of about 242° degrees magnetic and contained various fragments of wreckage along with portions of both wings, empennage, and engine. The wreckage was recovered to a secure location for further examination.

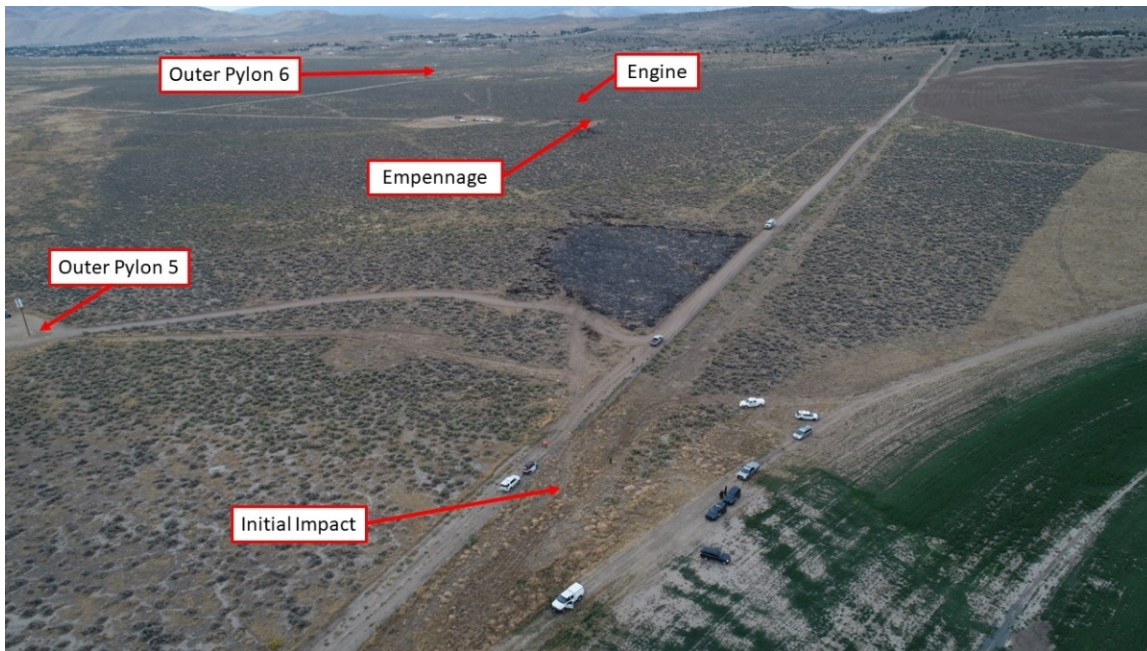


Figure 3: Aerial view of the accident site provided by Nevada State Patrol, with annotations of pylon and wreckage locations.

Examination of the recovered wreckage revealed that the majority of the airplane was severely fragmented. Remains of both wings, part of the fuselage, and empennage were observed. Multiple portions of flight control torque tubes were located within the recovered debris. All rod end bearings observed appeared secure to their torque tubes. All torque tube fractures appeared consistent with overload separation. No evidence of any preexisting mechanical malfunction with the recovered flight controls were observed.

Medical and Pathological Information

According to Federal Aviation Administration (FAA) records, the 61-year-old male pilot's last aviation medical examination was June 14, 2022. At that time, his reported medical history included high blood pressure, which the aviation medical examiner (AME) noted was under control and met Conditions AMEs Can Issue (CACI) criteria. The pilot's reported medical history also included low testosterone treated with medication, and a previous episode of chest pain in 2016 that led to a diagnosis of non-obstructive coronary artery disease; for these conditions, the pilot had been granted Authorization for Special Issuance of medical certification by the FAA.

At his most recent aviation medical examination, the pilot reported using the medications losartan and amlodipine (prescription medications used to treat high blood pressure), testosterone and anastrozole (prescription medications used to treat low testosterone), and valacyclovir (a prescription antiviral medication used as needed to treat cold sores). No significant issues were identified, and the pilot was issued a second-class medical certificate with the limitation, "Not valid for any class after 06/30/2023."

The pilot's FAA medical certification records documented that he underwent cardiac catheterization for coronary angiography in October 2017, after an abnormal nuclear stress test in 2016 for an episode of atypical chest pain. The 2017 cardiac catheterization demonstrated mild multivessel coronary artery disease (maximum stenosis approximately 25-30%), not requiring intervention, with intact left ventricular function. In November 2018, the pilot completed the process to obtain an Authorization of Special Issuance for third-class medical certification for non-obstructive coronary artery disease, low testosterone, and use of medication.

Subsequent authorizations were issued in August 2019 (for third-class medical certification), September 2020 (for second-class medical certification), and July 2021 (for second-class medical certification). Additional cardiac testing documented in FAA files included a May 2019 nuclear stress test, May 2020 echocardiogram, June 2020 and June 2021 exercise stress tests, and (most recently) April 2022 exercise stress echocardiogram. These tests were without diagnostic findings of ischemia. The 2020 echocardiogram showed mild left ventricular hypertrophy with a normal ejection fraction. The April 2022 stress echocardiogram was interpreted by a cardiologist as being normal (including normal left ventricle size and

systolic function, without evidence of inducible ischemia) and representative of very good exercise tolerance.

The pilot's two most recent Special Issuance Authorization letters included the warning, "Your heart disease places you at increased risk of in-flight cardiac impairment and sudden incapacitation when performing maneuvers involving increased G-forces. This is in addition to the baseline risk of G-LOC. For further information, please refer to FAA Advisory Circular AC-91-61 which can be downloaded here: [web address provided]."

The Washoe County Regional Medical Examiner's Office performed the pilot's autopsy. According to the pilot's autopsy report, his cause of death was blunt force injuries and his manner of death was accident. The extent of the pilot's injuries prevented structural evaluation of the heart and lungs, and the brain was not available for examination. Within these severe limitations, the autopsy did not identify significant natural disease.

At the request of the Medical Examiner's Office, NMS Labs performed postmortem toxicological testing of muscle tissue from the pilot. Caffeine was presumptively detected. No other tested-for substances were detected.

The FAA Forensic Sciences laboratory also performed toxicological testing of postmortem specimens from the pilot. This testing detected amlodipine in muscle and heart tissue. No blood was available for testing.

Caffeine is a central nervous system stimulant that is commonly ingested, including in coffee, tea, soft drinks, and chocolate; it is also an ingredient in certain anti-drowsiness medications and headache medications. Caffeine is not generally considered impairing.

Amlodipine is a prescription long-acting dihydropyridine calcium channel blocker medication that can be used to treat high blood pressure and certain types of coronary artery disease. Amlodipine is not generally considered impairing and is one of the acceptable medications under the FAA's CACI criteria for hypertension. However, because amlodipine acts by dilating peripheral blood vessels, in theory the drug may adversely affect G tolerance. The US Air Force does not permit amlodipine use by its high-performance aviators.

To a seated pilot, high positive vertical G force feels like being pushed down into the seat. Such force may be experienced during maneuvers such as high-speed turns or pull-up maneuvers. High positive vertical G force makes it harder for the heart to effectively pump blood to the brain. In some cases, this may result in brain hypoxia and G-induced loss of consciousness (G-LOC). Generally, when blood pressure to the brain drops too low, the body attempts to compensate by reflexively increasing heart rate and the volume of blood pumped with each heartbeat, and by constricting peripheral blood vessels. However, this response typically takes at least 6-9 seconds, and sometimes is not enough to prevent G-LOC. The physiologic reserve of brain function in the absence of blood flow is about 4-6 seconds.

In G-LOC, a pilot loses awareness, muscle control, and consciousness, and is unable to control the airplane. Once the vertical G force is reduced, a pilot who has experienced G-LOC will remain absolutely incapacitated by unconsciousness for a period, and then, upon regaining consciousness, will experience an additional period of relative incapacitation by confusion and disorientation. This results in a period averaging about 20-30 seconds after G force is reduced during which the pilot remains unable to control the airplane. Upon recovery from G-LOC, a pilot may not realize that it has occurred.

Vision loss (“tunnel vision,” “gray-out,” or “blackout”) due to diminished retinal blood flow might also occur with exposure to high positive vertical G force. Such vision loss may precede G-LOC, but does not reliably do so, particularly with rapid onset of high positive vertical G force, which can cause G-LOC to develop without warning. It is also possible for pilots to experience “almost loss-of-consciousness” (A-LOC) after short-duration, rapid-onset pulses of positive vertical G force. A-LOC is characterized by cognitive impairment, disorientation, and sensorimotor disturbance of shorter duration than G-LOC.

Multiple variables affect an individual’s G tolerance at any given time, including heart-to-brain distance, use of anti-G measures (such as an anti-G suit or an anti-G straining maneuver), hydration, nourishment, fatigue, physical conditioning (although aerobic conditioning without resistance training may actually decrease a person’s ability to compensate for G force), medical conditions, use of substances, experience and recency of G force exposure, and other factors.

Administrative Information

Investigator In Charge (IIC):	Cawthra, Joshua
Additional Participating Persons:	Ron Green; Federal Aviation Administration; Reno, NV Michael Steiger; Racing Jets Inc. Terrence Matter; Reno Air Racing Association; Reno, NV Todd Donahue; Reno Air Race Association; Reno, NV
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Note:	
Investigation Docket:	https://data.nts.gov/Docket?ProjectID=105962

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