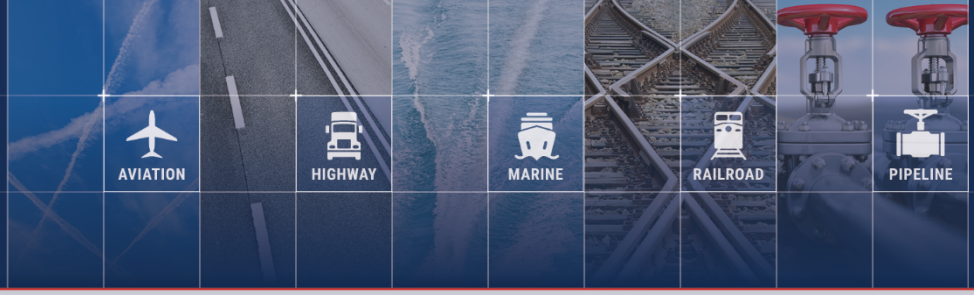

Aviation Investigation Final Report

Location:	Estes Park, Colorado	**Accident Number:**	CEN22FA035
Date & Time:	November 16, 2021, 18:36 Local	**Registration:**	N802NZ
Aircraft:	AIR TRACTOR INC AT-802A	**Aircraft Damage:**	Substantial
Defining Event:	Other weather encounter	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 137: Agricultural		

Analysis

The aerial firefighting flight was approaching the intended drop location when the airplane rolled inverted, descended, and impacted terrain. The airplane wreckage displayed features of a low-speed, nose-down impact with the engine producing power. The airplane sustained substantial damage to the fuselage, wings, and empennage. Recorded data showed decreasing indicated airspeed and increasing engine power toward the end of the flight. Postaccident examination of the airplane revealed no mechanical anomalies that would have precluded normal operation.

The accident site was located on the eastern slope of a high mountain range, and west winds gusting to near 30 knots were reported near the time of the accident. An animation of satellite imagery showed that most of the clouds west and east of the accident site did not propagate eastward with time with the mean wind but remained relatively stationary, which was consistent with mountain wave activity. Low cloud bands immediately south of the accident also remained relatively stationary and were likely rotor clouds, a type of cloud associated with severe or greater turbulence. It is likely the airplane encountered severe to extreme low altitude turbulence associated with rotor clouds, which resulted in the loss of control.

Probable Cause and Findings

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

The airplane’s encounter with severe to extreme turbulence associated with mountain wave rotor cloud activity, which resulted in loss of airplane control.

Findings

Environmental issues	(general) - Effect on operation
Environmental issues	Terrain induced turbulence - Effect on operation
Aircraft	Lateral/bank control - Attain/maintain not possible

Factual Information

History of Flight

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

On November 16, 2021, about 1836 mountain standard time, an Air Tractor Inc. AT-802A, N802NZ, was substantially damaged when it was involved in an accident near Estes Park, Colorado. The pilot was fatally injured. The airplane was operated as a Title 14 *Code of Federal Regulations* Part 137 aerial firefighting flight.

The purpose of the flight was to drop chemical retardant on the Kruger Rock fire in mountainous terrain. The pilot was using night vision goggles during the flight.

Video footage of the airplane showed the airplane's wings rocking as it approached the intended drop location. Two witnesses stated that they saw the airplane roll inverted but did not see it descend into terrain. One of the witnesses, who was in radio communication with the pilot, stated that he did not hear the pilot report any problems with the airplane nor make any distress calls before the accident.

Pilot Information

Certificate:	Airline transport; Flight instructor	**Age:**	59,Male
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	**Seat Occupied:**	Center
Other Aircraft Rating(s):	Gyroplane; Helicopter	**Restraint Used:**	
Instrument Rating(s):	Airplane; Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Gyroplane; Helicopter	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	March 31, 2021
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	April 22, 2020
Flight Time:	9200 hours (Total, all aircraft), 6400 hours (Pilot In Command, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	AIR TRACTOR INC	**Registration:**	N802NZ
Model/Series:	AT-802A	**Aircraft Category:**	Airplane
Year of Manufacture:	2015	**Amateur Built:**	
Airworthiness Certificate:	Restricted (Special)	**Serial Number:**	802A-0593
Landing Gear Type:	Tailwheel	**Seats:**	1
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	16000 lbs
Time Since Last Inspection:		**Engines:**	1 Turbo prop
Airframe Total Time:		**Engine Manufacturer:**	Pratt & Whitney Canada
ELT:		**Engine Model/Series:**	PT6A-67F
Registered Owner:	CO Fire Aviation Inc	**Rated Power:**	
Operator:	CO Fire Aviation Inc	**Operating Certificate(s) Held:**	Agricultural aircraft (137)

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Night
Observation Facility, Elevation:		**Distance from Accident Site:**	
Observation Time:		**Direction from Accident Site:**	
Lowest Cloud Condition:		**Visibility**	
Lowest Ceiling:		**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:		**Temperature/Dew Point:**	
Precipitation and Obscuration:			
Departure Point:	Fort Collins, CO (FNL)	**Type of Flight Plan Filed:**	None
Destination:	Estes Park, CO	**Type of Clearance:**	None
Departure Time:	18:13 Local	**Type of Airspace:**	Class G

The National Weather Service (NWS) Surface Analysis Chart valid for 1700 depicted a low-pressure system over Nebraska with a cold front extending southwestward across northern Colorado to another low-pressure system along a frontal wave over northeastern Utah. A high-pressure system was located over southwestern Colorado with a mesoscale ridge extending northeastward over the general vicinity of the accident site. The accident site was located

immediately south of the cold front in an area with a strong pressure gradient. The station models immediately surrounding the accident site depicted west winds at 20 to 40 knots, clear to scattered clouds, and temperatures ranging from 60°F ahead of the front to 39°F over southern Wyoming northwest of the accident site and on the cold-air side of the front.

The next NWS Surface Analysis Chart for 2000 depicted the low-pressure system over Nebraska having moved southward into eastern Colorado with the cold front extending westward across Colorado and located south of the accident site. The station models surrounding the accident site depicted west-northwest winds at 40 knots, scattered to broken skies to the west and northwest of the accident site, and temperatures at 51°F immediately east and 32°F to the northwest of the accident site.

The closest official weather reporting site was Vance Brand Airport (LMO), Longmont, Colorado, located about 18 miles southeast of the accident site at an elevation of 5,055 ft. The routine weather observation for LMO at 1835 reported wind from 200° at 11 knots gusting to 17 knots, wind direction variable from 170° to 230°, visibility 10 miles or more, scattered clouds at 11,000 ft above ground level (agl), temperature 17°C, dew point temperature -8°C, and altimeter setting 29.78 inches of mercury.

A review of the observations at LMO indicated west winds gusting from 20 to 35 knots from about 0955 to 1500 and winds backing or changing anti-cyclonically to the southwest with decreasing wind speeds through 1600. Winds further decreased in speed to less than 10 knots between 1600 and 1815 and shifted direction to the east. Winds again shifted to the south to west-southwest at 1835 with wind speeds increasing again immediately before the accident with gusts to 29 knots at 1915 before decreasing again at 2115.

The area was also reviewed for any available Remote Automated Weather Stations (RAWS) operated by the United States Forestry Service, other land management agencies, and the Colorado Department of Transportation (CDOT).

Lily Lake (CO045), a CDOT station at an elevation of 8,960 ft, about 3.3 miles southwest of the accident site, reported the following conditions at 1849:

Temperature:	41°F	Max 24-hr Temperature: 49°F
Dew Point:	15°F	Min 24-hr Temperature: 45°F
Relative Humidity:	36%	
Wind:	225° 7 knots	
Peak Gust:	28 knots	
Max Gust:	38 knots at 1748	

Estes Park (ESPC2) at an elevation of 7,892 ft, about 4.3 miles west-northwest of the accident site, reported the following conditions at 1824:

Temperature:	44°F	Max 24-hr Temperature: 57°F
Dew Point:	21°F	Min 24-hr Temperature: 44°F
Relative Humidity:	39%	
Wind:	260° 11 knots	
Peak Gust:	28 knots	
Max Gust:	39 knots at 1424	

Boulder County Fire (BCFC2) at an elevation of 6,674 ft, about 9.6 miles southwest of the accident site, reported the following conditions at 1742:

Temperature:	51°F	Max 24-hr Temperature: 61°F
Dew Point:	19°F	Min 24-hr Temperature: 51°F
Relative Humidity:	28%	
Wind:	280° 7 knots	
Peak Gust:	32 knots	
Max Gust:	43 knots 1642	

The Geostationary Environmental Satellite number 16 (GOES-16) infrared image for 1836 depicted an area of low- to middle-level clouds to the west of the accident site in a general north-to-south orientation pattern similar to transverse banding or trapped lee waves. The GOES-16 image also showed a relatively clear gap (or foehn gap) over and east of the accident site and a band of enhanced higher clouds further east through southeast of the accident site. When observed at high levels, transverse bands, which are bands of clouds oriented perpendicular to the flow in which they are embedded, may indicate severe or extreme turbulence. Transverse bands observed at low levels often indicate the presence of a

temperature inversion as well as directional shear in the low- to mid-level winds. A foehn gap is a break in an extensive cloud deck or cloud shield, usually parallel to and downwind of a mountain ridge line. Especially visible in satellite imagery, this cloud-free zone results from the strong sinking motion on the lee side of a mountain barrier during mountain wave activity or strong downslope winds.

The GOES-17 infrared image for 1836 showed similar features of a transverse cloud pattern associated with orographic clouds over the area. An animation of the satellite imagery showed that most of the clouds west and east of the accident site did not propagate eastward with time with the mean wind but remained relatively stationary. The low cloud bands immediately south of the accident site also remained relatively stationary and were consistent with rotor clouds. Rotor (or roll) clouds are a turbulent cloud formation found in the lee of some mountain barriers when winds cross the barrier at high speed.

The NWS had SIGMET Uniform 15 current over the area for moderate to occasional severe turbulence below 18,000 ft due to strong low-level winds. SIGMET Xray 4 was current for severe turbulence between 25,000 and 42,000 ft due to wind shear associated with the jet stream and mountain wave activity. The NWS also had Graphic-AIRMET Tango for moderate turbulence from the surface to 18,000 ft and low-level wind shear below 2,000 ft agl over the region at the time.

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	40.3351,-105.4774(est)

The airplane wreckage was upright and displayed features of a low-speed, nose-down impact with sloping and wooded terrain. There was no ground scarring that preceded the wreckage. The wreckage did not display asymmetric wing damage consistent with yaw/bank on impact, and there was no lateral displacement of the empennage consistent with yaw on impact. The airplane sustained substantial damage to the fuselage, wings, and empennage. The propeller exhibited torsional bending/twisting consistent with the engine producing power at the time of impact. Postaccident examination of the wreckage revealed no mechanical anomalies that would have precluded normal operation.

Flight recorders

Download of the Flight Data Acquisition Storage and Transmission System showed decreasing indicated airspeed and increasing engine interstage turbine temperature, gas producer speed, propeller speed, engine torque, and fuel flow toward the end or the recording.

Medical and Pathological Information

The autopsy report stated the pilot died of multiple blunt force injuries. The Federal Aviation Administration Forensic Toxicology Report was negative for all substances tested.

Administrative Information

Investigator In Charge (IIC):	Gallo, Mitchell
Additional Participating Persons:	Matt Cady; Federal Aviation Administration, Denver FSDO; Denver, CO John Waddell; Department of the Interior, Office of Aviation Services; Boise, ID Dakota Lowe; Air Tractor, Inc.; Olney, TX Jeffery Davis; Pratt&Whitney Canada Beverley Harvey; Transportation Safety Board
Original Publish Date:	April 19, 2023
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Investigation Class:	Class 3
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=104254