Aviation Investigation Final Report

Location:	Stevens Point, Wisconsin	**Accident Number:**	CEN14FA266
Date & Time:	June 1, 2014, 12:22 Local	**Registration:**	N176FD
Aircraft:	Yakovlev YAK-55M	**Aircraft Damage:**	Substantial
Defining Event:	Loss of control in flight	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 91: General aviation - Air race/show		

Analysis

The pilot was performing an aerobatic flight at an airshow event when the accident occurred. The flight team manager witnessed the accident and reported that the airplane entered an intentional inverted flat spin at the apex of an inside loop maneuver. The airplane completed more than 3 rotations in the inverted flat spin before recovering into a dive. The team manager then saw the airplane pitch up and enter an "aggressive" left turn. A review of ground-based video footage confirmed the sequence of events reported by the team manager and showed that, after the pitch up and left roll, the airplane entered a nose-low, descending left spiral that continued to ground impact. The observed flight path was consistent with an accelerated aerodynamic stall after the pilot had recovered from the inverted spin at a low altitude. The airplane cockpit was equipped with an aft-facing video camera that captured the pilot and his flight control movements. A review of the available cockpit footage confirmed that the pilot remained conscious throughout the accident flight and that the ailerons, elevator, and engine had responded to his control inputs. Although the rudder was obstructed from view in the video by the pilot's helmeted head, his observed leg movements were consistent with expected rudder inputs throughout the flight. Further, a postaccident examination of the airplane did not reveal any mechanical anomalies that would have precluded normal operation.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:
The pilot's failure to maintain airplane control during the aerobatic flight, which resulted in the airplane exceeding its critical angle of attack and entering an accelerated stall at a low altitude.

Findings

Personnel issues	Aircraft control - Pilot
Aircraft	Angle of attack - Capability exceeded

Factual Information

History of Flight

Maneuvering-aerobatics	Loss of control in flight (Defining event)
Maneuvering-aerobatics	Aerodynamic stall/spin
Uncontrolled descent	Collision with terr/obj (non-CFIT)

On June 1, 2014, about 1222 central daylight time, a Yakovlev YAK-55M airplane, N176FD, was substantially damaged when it impacted terrain during an aerobatic flight over the Stevens Point Municipal Airport (STE), Stevens Point, Wisconsin. The airline transport pilot was fatally injured. The airplane was registered to and operated by the pilot under the provisions of 14 *Code of Federal Regulations* (CFR) Part 91 without a flight plan. Day visual meteorological conditions prevailed for the local airshow demonstration flight that departed about 1220.

The flight team manager, who provided the public announcement during the aerobatic flight, reported that the flight began with the airplane rolling inverted shortly after liftoff on runway 21 and making a shallow inverted climb past show center. The airplane then rolled upright before entering a 90° turn away from show center and the crowd. The airplane continued to climb as it turned to a heading opposite that of the takeoff runway, turned back to the runway heading, and reentered the aerobatic box. The airplane rolled inverted before it entered a 45° dive toward show center. The airplane then completed several descending aileron rolls before it rolled wings level and entered a near vertical climb. At the apex of the climb/loop, the airplane entered an inverted flat spin. The flight team manager stated that the pilot normally entered the inverted flat spin at 3,000 ft above ground level (agl) and completed three rotations before recovering in a vertical dive with a 4-5 g pullup at show center; however, on the accident flight, the pilot appeared to enter the inverted spin about 500 ft lower than normal and complete more than 3 rotations before recovering into a dive. According to the the flight team manager, the airplane then pitched up and entered an "aggressive" left turn that resulted in an accelerated aerodynamic stall.

A review of ground-based video footage showed that the airplane had completed 3-1/2 rotations in the inverted flat spin before it entered a near-vertical dive. The airplane pitched up momentarily before it developed a rapid left roll. The airplane subsequently entered a nose-low, descending left spiral that continued to ground impact.

Pilot Information

Certificate:	Airline transport	**Age:**	47,Male
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	**Seat Occupied:**	Single
Other Aircraft Rating(s):	Glider	**Restraint Used:**	5-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 Without waivers/limitations	**Last FAA Medical Exam:**	March 24, 2014
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	May 12, 2014
Flight Time:	8266 hours (Total, all aircraft), 107.5 hours (Total, this make and model), 184.1 hours (Last 90 days, all aircraft), 36 hours (Last 30 days, all aircraft), 0.8 hours (Last 24 hours, all aircraft)		

According to Federal Aviation Administration (FAA) records, the 47-year-old pilot held an airline transport pilot certificate with single engine land and sea, multiengine land, and instrument airplane ratings. The pilot was type-rated for the Airbus A320, Boeing 757, Boeing 767, McDonnell Douglas DC-9, and Douglas DC-3 transport category airplanes. He also held a glider rating. The single engine land and sea airplane ratings were limited to commercial privileges. The glider rating was limited to private privileges. The pilot's last aviation medical examination was completed on March 24, 2014, when he was issued a first-class medical certificate with no restrictions or limitations. On September 16, 2013, the pilot completed an evaluation flight and was issued a Statement of Aerobatic Competency. A search of FAA records showed no previous accidents, incidents, or enforcement proceedings. His last flight review, as required by 14 CFR Part 61.56, was completed on May 12, 2014.

The pilot's flight history was established using his pilot logbook. His most recent logbook entry was completed on May 28, 2014, at which time he had accumulated 8,266.1 hours total flight time, of which 3,628.5 hours were listed as pilot-in-command. According to the logbook, the pilot had accumulated 3,608.8 hours in single-engine airplanes, 4,649.7 hours in multi-engine airplanes, and 4.7 hours in gliders. The pilot had flown 184.2 hours during the 90 days before the accident, 36 hours in the month before the accident, and 0.8 hours during the 24-hour period before the accident. The pilot had accumulated 107.6 hours in the accident airplane make/model. According to available documentation, the pilot had completed one aerobatic training flight in his authorized aerobatic practice box during the 8-month period before the accident. The single aerobatic training flight was completed on May 28, 2014, in the accident airplane.

Aircraft and Owner/Operator Information

Aircraft Make:	Yakovlev	**Registration:**	N176FD
Model/Series:	YAK-55M	**Aircraft Category:**	Airplane
Year of Manufacture:	1993	**Amateur Built:**	
Airworthiness Certificate:	Experimental (Special)	**Serial Number:**	930810
Landing Gear Type:	Tailwheel	**Seats:**	1
Date/Type of Last Inspection:	September 29, 2013 Condition	**Certified Max Gross Wt.:**	2150 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	214.5 Hrs as of last inspection	**Engine Manufacturer:**	Vedeneyev
ELT:	Not installed	**Engine Model/Series:**	M14P
Registered Owner:	On file	**Rated Power:**	360 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The airplane was a 1993 Yakovlev YAK-55M, serial number 930810. It was an aerobatic single-place, single-engine airplane with a fixed conventional landing gear. The airplane was powered by a 360-horsepower, 9-cylinder Vendeneyev M14P radial engine, serial number KR0312035. The engine provided thrust through a constant-speed, three-blade, MT-Propeller MTV-9-B-C propeller, serial number 110600. The airplane had a maximum allowable takeoff weight of 2,150 pounds. The pilot purchased the airplane on October 17, 2010. The airplane was issued an FAA experimental category airworthiness certificate for the purpose of exhibition and associated operating limitations on December 7, 2010.

According to the airplane maintenance records, the most recent condition inspection was completed on September 29, 2013. At the time of that inspection, the airframe and engine had accumulated 214.5 hours total time. The propeller had accumulated 51.4 hours total time. The last recorded maintenance was an engine oil change that was completed on May 22, 2014. A postaccident review of the maintenance records found no history of unresolved airworthiness issues. The recording hour (Hobbs) meter was damaged during the accident, and a definitive reading could not be obtained.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	STE,1110 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	12:15 Local	**Direction from Accident Site:**	283°
Lowest Cloud Condition:		**Visibility**	10 miles
Lowest Ceiling:	Broken / 2900 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	14 knots / 21 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	200°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.89 inches Hg	**Temperature/Dew Point:**	26°C / 19°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Stevens Point, WI (STE)	**Type of Flight Plan Filed:**	None
Destination:	Stevens Point, WI (STE)	**Type of Clearance:**	None
Departure Time:	12:20 Local	**Type of Airspace:**	Class G

At 1215, an automated surface weather observation station located at STE reported: wind 200° at 14 knots, gusting 21 knots; broken cloud ceilings at 2,900 ft agl and 3,600 ft agl; 10 miles surface visibility; temperature 26° Celsius; dew point 19° Celsius; and an altimeter setting of 29.90 inches of mercury.

Airport Information

Airport:	Stevens Point Municipal STE	**Runway Surface Type:**	Asphalt
Airport Elevation:	1110 ft msl	**Runway Surface Condition:**	Dry
Runway Used:	21	**IFR Approach:**	None
Runway Length/Width:	6028 ft / 120 ft	**VFR Approach/Landing:**	None

The Stevens Point Municipal Airport, located about 3 miles northeast of Stevens Point, Wisconsin, was served by two asphalt runways, runway 3/21 (6,028 ft by 120 ft) and runway 12/30 (3,635 ft by 75 ft). The airport elevation was 1,110 ft mean sea level.

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	44.543334,-89.52111

The accident site was located alongside a dirt road in a wooded area about 260 yards northeast of the runway 30 threshold. The elevation of the accident site was 1,095 ft. The main wreckage consisted of the entire airplane, which was orientated on a northwest heading. The wreckage was found in an upright position, and there was no appreciable wreckage debris path. The observed tree damage and the lack of a lateral debris path were consistent with a near vertical impact. All observed structural component failures were consistent with overstress separation, and there was no evidence of an inflight or postimpact fire. Flight control continuity was confirmed from all flight control surfaces to their respective cockpit controls. The engine was found in a 2.5 ft deep impact crater and remained partially attached to the firewall. Three engine cylinders had partially separated from the crankcase, which prevented the engine from being rotated. After removing several cylinders, an internal examination did not reveal any mechanical discontinuities within the engine drivetrain. The No. 1 magneto exhibited impact damage that prevented a functional test. The No. 2 magneto provided a spark on all leads when rotated. All three propeller blades were fragmented, consistent with the engine producing power at the time of impact. The postaccident examination of the airplane did not reveal any mechanical anomalies that would have precluded normal operation.

Medical and Pathological Information

At the request of the Portage County Coroner, an autopsy was performed on the pilot at the University of Wisconsin-Madison School of Medicine and Public Health, located in Madison, Wisconsin. The cause of death was attributed to multiple blunt-force injuries sustained during the accident. The FAA Bioaeronautical Sciences Research Laboratory located in Oklahoma City, Oklahoma, performed toxicology tests on samples obtained during the autopsy. The toxicological test results were negative for ethanol and all drugs and medications.

Tests and Research

A Garmin GPSMAP 396, serial number 67014609, was recovered from the wreckage and examined at the NTSB Vehicle Recorder Laboratory. The non-volatile data was recovered through a memory-chip recovery process. The final dataset was recorded on May 31, 2014, and was associated with a 0.8-hour flight from Menomonie Municipal Airport (LUM) to STE. The Garmin GPSMAP 396 device did not contain any data associated with the accident flight.

A GoPro Hero 3+ digital video camera, serial number 30C3CDE, was recovered from the wreckage and examined at the NTSB Vehicle Recorder Laboratory. A forensic recovery of the memory card revealed eight video files. Seven of the eight video files were not associated with the accident flight. The remaining video file contained 4 minutes 37 seconds of video footage from the accident flight.

A review of the available video footage established that the camera was mounted on the glare shield facing aft toward the pilot. The pilot's helmeted head, torso, hips, upper legs, and knees were in the field-of-view. Also visible were the pilot control stick, the inboard portions of both ailerons, the outboard portions of both horizontal stabilizers, and both elevator horns/counterbalances. The vertical stabilizer and rudder were obscured by the pilot's helmeted head. The video camera also recorded audio that detected changes in wind and engine noise during the accident flight.

A review of the video footage established that the flight controls were moving in conjunction with the pilot's control inputs and that he closed and locked the canopy before takeoff. The pilot initiated the takeoff by advancing the engine power lever gradually with his left hand. The airplane became airborne in a level attitude while over the runway 21 centerline. About 8 seconds after liftoff, the pilot activated the smoke system with his right thumb on the control stick, and the airplane briefly entered a slight climb before it rolled to the right into an inverted attitude. The inverted airplane was slightly left of the runway 21 centerline. The pilot then pushed the control stick forward to initiate an inverted climb. During the inverted climb, the pilot turned the airplane away from the showline and eventually rolled the airplane upright and continued in a climbing left turn onto a downwind for runway 21. While on the downwind, the pilot made a radio call and activated the airplane's smoke system several times. The airplane continued to climb on the left crosswind and eventually turned upwind for runway 21.

At 03:53 (mm:ss) into the recording, the pilot made a radio call, activated the smoke system, and rolled the airplane inverted. After rolling inverted, the airplane continued to fly level briefly before the pilot applied aft control stick with both hands to establish a descending flight path of about 45°. The airplane then completed 2-1/2 right aileron rolls while descending, and smoke was observed trailing the airplane's flight path. By 04:06, the airplane was upright and wings level. The airplane then entered an inside loop maneuver. While the airplane was ascending, the two intersecting runways were visible outside the airplane's canopy. The longitudinal axis of the airplane appeared to be about 20° offset to the runway 3/21 centerline. At 04:17, the pilot reduced engine throttle, and the recorded audio track was consistent with a partial reduction in engine power. About 1 second later, the unrestrained portion of the pilot's shoulder harness straps (strap ends) fell toward the top of the airplane's canopy indicating the airplane had entered a negative-g environment. The pilot applied slight forward control stick with his right hand. By 04:19, the pilot further reduced the engine throttle and applied additional forward control stick input. The airplane's heading remained offset about 20° from the runway 3/21 centerline. The

elevator horns/counterbalances showed that the elevator was near maximum deflection as the control stick approached the full forward position. The pilot then applied a left rudder input while holding the control stick in the full forward position. The observed smoke trail was consistent with the airplane yawing. By 04:27, the airplane was established in an inverted spin and had completed one rotation. The pilot was still holding full forward stick with some right aileron input. The airplane completed several rotations while in the inverted spin before the pilot began to move the control stick forward and applied right rudder. The airplane's rotation rate began to slow, and by 04:31, the control stick was being held in a neutral pitch position. The elevator was observed in a neutral position when compared to the horizontal stabilizer. The pilot then moved the control stick to the right, and both ailerons were observed to move in conjunction with the control stick position. The shoulder harness straps were still floating, consistent with the airplane still in a negative-g environment. The pilot was holding the control stick with a clenched right hand. At 04:32, the pilot applied a rapid left aileron and left rudder control input. The ailerons were observed to respond to the control stick movement. The shoulder harness straps were no longer floating, consistent with the airplane in a positive-g environment. The airplane rotation stopped, and there was an increase in engine noise.

About a second after the rotation had stopped, the pilot quickly centered the control stick before moving the control stick aft. The elevator was observed to move in conjunction with the control stick movement. The ailerons appeared to be in a neutral position as the airplane pitched up from a nose-low descent toward level flight. Within the next 2 seconds, the horizon became visible behind the airplane. The upright airplane was banked slightly to the right as the airplane neared a level flight attitude. At 04:34, the pilot moved his head to look over his right shoulder. The airplane continued to pitch up and subsequently entered a level climb. The pilot then turned his head back toward the center of the cockpit, his right hand was still firmly griping the control stick, and his left hand was on the engine throttle. Runway 3/21 was observed directly behind the airplane and perpendicular to the airplane's flight path. The airplane then entered an abrupt left roll with a positive pitch angle. The pilot had not commanded the left roll with aileron or rudder control input. The control stick position was consistent with an aft pitch and a neutral roll input. The observed positions of the ailerons and elevator were consistent with the control stick position.

The video footage was analyzed frame-by-frame, and the left roll rate appeared to increase rapidly between frames. The pilot was still griping the control stick with his right hand while his left hand remained on the engine throttle. As the left roll developed, the pilot moved the control stick to the right and partially reduced the aft pitch. The airplane continued to roll left, and the runway 30 threshold markings became visible below the airplane. During the left roll, the pilot added additional right roll control and further reduced the aft pitch input. The ailerons and elevator responded to the control stick movement. Throughout the left roll, the pilot was looking forward, and his right hand remained on the control stick and his left hand on the engine throttle. At 04:37, the video footage ended with the airplane still airborne and rolling to the left. The airplane had rolled beyond 90° to the horizon and the runway 30 threshold markings were still visible under the airplane. The final impact sequence was not recorded by the video camera. However, during the final seconds of recorded video, the pilot's body positioning, active head movements, and flight control movements were consistent with him being conscious. Additionally, the review of the available video footage confirmed that the pilot had remained conscious throughout the aerobatic flight.

Administrative Information

Investigator In Charge (IIC):	Fox, Andrew
Additional Participating Persons:	Darrell C McCullion; Federal Aviation Administration - Milwaukee FSDO; Milwaukee, WI Rob Holland; International Council of Airshows (ICAS); Leesburg, VA
Original Publish Date:	May 3, 2017
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=89326