Aviation Investigation Final Report

Location:	ANCHORAGE, Alaska	**Accident Number:**	ANC98FA110
Date & Time:	July 26, 1998, 11:09 Local	**Registration:**	N354AM
Aircraft:	Yakovlev YAK-54	**Aircraft Damage:**	Destroyed
Defining Event:		**Injuries:**	2 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot and a pilot-rated passenger, flying a Russian built unlimited class aerobatic airplane, joined a second aerobatic airplane for a planned photo flight. The two airplanes flew alongside each other while the passengers took photographs. The photo flight altitudes varied between 2,600 and 3,400 feet msl. After the photo session was completed, the pilot of the accident airplane stated he was going to demonstrate some aerobatic maneuvers to his passenger. During a turn, the pilot of the second airplane momentarily lost sight of the accident airplane. When he regained sight of the accident airplane, he estimated it was between 2,700 to 3,000 feet msl, in what appeared to be an inverted right spin. The spin continued for between 5 to 7 turns until the airplane collided with trees. The accident airplane was being operated in the United States under an experimental/exhibition airworthiness certificate. It has light control forces, and a roll rate of 340 degrees per second. No preimpact mechanical malfunction was found. The pilot was an active U.S. Air Force Lt. General with extensive military experience. He had accrued 16.6 hours in the accident airplane. According to his logbook, he had practiced several aerobatic manuevers in the airplane, including incipient inverted spins, and inverted and upright flat spins. The accident pilot and passenger had previously flown aerobatic airplanes together. The passenger had competed in aerobatic airplanes in the past. He did not have any experience in the accident airplane. The airplane flight manual recommends an altitude of 1,500 meters (4,922 feet) prior to initiating spins.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The pilot's inadequate remedial action to recover from an inverted spin, while performing aerobatics. Contributing factors were the lower than recommended entry altitude for a spin and the pilot's lack of familiarity with the accident airplane.

Findings

Occurrence #1: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: MANEUVERING

Findings
1. AEROBATICS - PERFORMED - PILOT IN COMMAND
2. STALL/SPIN
3. (C) REMEDIAL ACTION - INADEQUATE - PILOT IN COMMAND
4. (F) LACK OF FAMILIARITY WITH AIRCRAFT - PILOT IN COMMAND

Occurrence #2: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: DESCENT - UNCONTROLLED

Findings
5. (F) ALTITUDE - INADEQUATE - PILOT IN COMMAND

Factual Information

HISTORY OF FLIGHT

On July 26, 1998, about 1109 Alaska daylight time, a Russian built, unlimited class aerobatic Yakovlev Yak-54 airplane, N354AM, was destroyed after colliding with trees and terrain on the Fort Richardson Army Base, about 14 miles north of Anchorage, Alaska. The airplane was being operated as a visual flight rules (VFR) local area personal flight under Title 14, CFR Part 91, when the accident occurred. The airplane was registered to Red Eagle Flying LLC, Anchorage, and operated by the pilot/owner. The airplane was operated in the United States under a special airworthiness certificate in the experimental/exhibition category. The certificated commercial pilot, and the pilot-rated passenger, received fatal injuries. Visual meteorological conditions prevailed. The flight originated at the Elmendorf Air Force Base, Anchorage, about 1030.

The pilot, a U.S. Air Force Lt. General at Elmendorf AFB, and the passenger, departed Elmendorf AFB and joined a second airplane in restricted airspace R-2203 to photograph each airplane. No airspace restrictions were in effect during the flight. The airspace overlies military reservation land on the Fort Richardson Army Base. The second airplane, a Sukhoi SU-29, N329SU, occupied by the pilot and a passenger, departed from Merrill Field, Anchorage.

The pilots and passengers of both airplanes met at Merrill Field about 0930, and conducted a briefing about the photo flight. The briefing included primary and secondary communications frequencies, key landmarks, weather, and emergency landing areas. After the briefing, each pilot departed their respective airports about 1030. After takeoff from Elmendorf AFB, the accident airplane was assigned a transponder code of 0154 by an Anchorage Air Route Traffic Control Center (ARTCC) controller. After departure from Merrill Field, the SU-29 was assigned a transponder code of 0151. The two airplanes rendezvoused in R-2203. Upon reaching the area, the pilot of the SU-29 was told by ARTCC to place his transponder on "standby." The two airplanes then flew alongside each other while the passengers of each airplane took photographs. The pilots of each airplane were seated in the rear seat of their respective airplanes which is the pilot-in-command position. Both seats of each airplane were equipped with full functioning dual flight controls.

The pilot of the SU-29 reported that after the photography session was completed, he planned to return to Merrill Field. He began to fly northward about 3,000 feet msl, diverging away from the accident airplane that was flying southbound. During a radio conversation, the pilot of the accident airplane stated he was going to demonstrate some aerobatic maneuvers to his passenger. The pilot and passenger of the SU-29 saw a hammerhead turn to the right, followed by a 4-point roll. The roll was conducted at an altitude lower than the SU-29. While he was making a turn toward the south, the pilot of the SU-29 momentarily lost sight of the Yak-54

airplane. After completing his turn, the pilot of the SU-29 reported he regained sight off the YAK-54. He estimated he was about 3 miles north of the accident airplane.

When visual contact was regained with the YAK-54, it was facing north at an altitude higher than what was used for the previous 4-point roll, and the airplane had just entered a spin. The SU-29 pilot said he estimated the altitude of the YAK-54 between 2,700 and 3,000 feet msl, and descending. He said the position of the airplane seemed to indicate the YAK-54 had performed a course reversal, and a gain in altitude, prior to the spin. The spin appeared to be upright, and to the right. The SU-29 pilot estimated the spin rotation around 300 degrees per second, with the nose of the airplane about 70 to 80 degrees below the horizon. The SU-29 pilot described the spin as "normal," but at an altitude lower than he expected. The accident airplane continued to descend in the spin without noticeable variation, for between 5 to 7 turns, until it collided with trees. Both the pilot and passenger of the SU-29 looked for parachutes, but saw none. The SU-29 pilot then made radio contact with the Anchorage ARTCC, and reported the accident.

Following the accident, the pilot and passenger of the SU-29 both submitted written descriptions of the accident events. They also provided an addendum to their written statements. Each addendum included a revision of their observations of the accident airplane. After review of photographs of the accident airplane, and comparison between the color of the airplane and their observation of the spin, both occupants of the SU-29 reported the accident airplane appeared to be in an inverted spin.

The accident occurred during the hours of daylight at latitude 61 degrees, 20.712 minutes north, and longitude 149 degrees, 39.931 minutes west.

CREW INFORMATION

The pilot held a commercial pilot certificate with airplane single-engine land, multiengine land, instrument airplane, and glider ratings. In addition, he held a flight instructor certificate with airplane single-engine, and instrument airplane ratings. His most recent second-class medical certificate was issued on February 26, 1998, and contained the limitation that he must wear corrective lenses.

The pilot's military career included flying about 40 different models of aircraft, and he had accumulated about 4,400 hours of military flight time. He routinely operated high performance military fighter aircraft. He received "G" awareness training, including centrifuge training, on October 30, 1990.

The pilot received a Statement of Aerobatic Competency (FAA Form 8710-7) from the FAA in November, 1996. The pilot's statement of aerobatic competency was issued for solo and formation aerobatics at Level 4 (minimum altitude of 800 feet above the ground), in a L-39/Yak-52 airplane. The pilot applied for the form on November 3, 1996, by undergoing an evaluation from an Airshow Certification Evaluator (ACE). In partnership with the FAA, the ACE

program is administered by the International Council of Air Shows, Inc. After evaluation, a pilot's application for an 8710-7 card is reviewed by an FAA inspector who then may issue a card. The card is valid for 12 months.

Examination of the pilot's logbook, and review of a recent application for aviation insurance, revealed that his total civil aeronautical experience consisted of about 1,600 hours. In the preceding 90 and 30 days prior to the accident, the logbook listed a total of 42.7 and 22.8 hours respectively. His total Yak-54 flight time was 16.6 hours. His last flight in the Yak-54, prior to the accident flight, was on July 22, 1998, when .8 hours were logged.

The pilot received a check-out in a Yak-54 airplane on April 14, 1998. He accrued 2.6 hours of training in the airplane from an aerobatic demonstration pilot employed by the importer of the airplane. During the check-out, the demonstration pilot reported the pilot tended to pull hard on the flight controls during aerobatic maneuvers.

After delivering the accident airplane to Anchorage, the demonstration pilot indicated that marginal weather conditions contributed to delays in scheduling additional training time in the airplane. Therefore, the accident pilot received no additional instruction in the airplane.

The pilot began flying in the accident airplane on June 21, 1998. He accrued an additional 14.0 hours in the Yak-54 before the accident. The pilot noted the type of aerobatic maneuvers he practiced in the accident airplane in his logbook. These included hammerhead stalls, 4 point rolls, inside and outside loops, upright and inverted stalls, immelmans, torque rolls, snap rolls, vertical rolls, normal spins, incipient inverted spins, and inverted and upright flat spins. The pilot noted having experienced up to +8 Gs and -4 Gs in the accident airplane.

The passenger held a commercial pilot certificate with an airplane single-engine land rating, limited to carrying passengers for hire only during daylight, and not more than 50 nautical miles from the point of departure. The most recent second-class medical certificate was issued to the pilot on July 23, 1996, and contained the limitation that the pilot must wear corrective lenses. In addition, the passenger held a private pilot certificate with a glider rating, issued on the basis of, and valid only when accompanied by, South Africa Pilot Certificate 1100.

The passenger's pilot logbook revealed no flight time entries after December 31, 1997. The passenger's wife indicated he was still actively flying. The passenger's logbook indicated a total time of 940 hours. He had previously competed in aerobatic competitions, and he had not logged any flight time in a Yak-54.

The pilot and the passenger had previously flown together in several airplanes, and had joint ownership in a Yakovlev Yak-52 airplane. The pilot accrued about 195 hours in a Yak-52. The passenger accrued about 67 hours in a Yak-52.

AIRCRAFT INFORMATION

The airplane was designed by the Yakovlev Design Bureau, Moscow, Russia. It was manufactured by the Saratov Aviation Plant, Saratov, Russia, on August 26, 1997. It is a mid-wing, tailwheel equipped monoplane with tandem seating, and a jettisonable canopy. The airplane is designed for aerobatic training, and unlimited class aerobatic competition. The U.S. importer of the airplane was the Northwest Aerobatic Center, Ephrata, Washington.

Personnel from the Yakovlev Design Bureau provided the following information: The airplane is rated for nine positive Gs, and seven negative Gs. It has a roll rate of 340 degrees per second. Yakovlev Design Bureau personnel reported that according to their flight test data, at an aft center of gravity (CG) of 37 percent mean aerodynamic chord (MAC), the airplane exhibited neutral stability, but was easily controlled. At a forward CG of 30 percent MAC, the stick force per G is 4 kg (8.8 pounds). At an aft CG (37 percent MAC), the stick force per G is 1 kg (2.2 pounds). The airplane has an aerodynamic buffet that occurs before a stall. The altitude needed to recover from an upright stall was 820 feet, and 984 feet for an inverted stall. The airplane did not demonstrate any tendency to enter an inadvertent spin during stall testing.

Additionally, Yakovlev Design Bureau personnel reported that upright and inverted spins were steep and stable. The angle of attack during a normal spin was 40 to 50 degrees, with a recovery in 1/2 turn. The altitude loss for a 3-turn spin was reported to be 1,969 to 2,133 feet. The altitude loss for a 6-turn spin was 2,625 to 2,789 feet. The load factors during spin recovery did not normally exceed 2.5 Gs. A flat spin had an angle of attack of 60 degrees, with 1 turn for recovery. The altitude loss during a 6-turn flat spin was 2,297 to 2,461 feet.

For training purposes, the airplane's flight manual specifies a minimum altitude of 1,500 meters (4,922 feet) prior to initiating spins.

According to the airplane's flight manual (First printing, dated June 1, 1996), the airplane has an allowable CG range of 29 to 35 percent MAC. The importer of the airplane reported he obtained a revised allowable aft limit of 36.7 percent MAC from the Yakovlev Design Bureau. The revised aft limit data was also included in information provided to the Safety Board by the Yakovlev Design Bureau. The importer of the airplane converted the CG calculations and CG limits from percent MAC to inches. The datum used for CG calculations is the airplane's firewall. The empty weight of the airplane is 1,766 pounds. The maximum gross weight of the airplane is 2,391 pounds. The importer listed the weight of a parachute as 13 pounds.

Review of service range, and endurance data contained in the airplane flight manual, revealed a fuel reserve of 17 kg. The flight manual data indicated 1.5 kg of fuel would be used for engine start, warm-up, and taxi. Three kg of fuel would be used for takeoff and climb to 1,000 meters (3,280 feet). Minimum fuel reserve for a guaranteed seven percent margin, was listed as 9.8 kg of fuel. The importer of the airplane stated an average fuel burn is approximately one liter per minute.

The following data was utilized by the National Transportation Safety Board investigator-in-

charge (IIC), for CG calculations.

One meter equates to 39.37 inches. One liter of fuel equates to .72 kg. One gallon of fuel equates to 2.73 kg. One gallon equates to 3.7854 liters. A MAC of 29 percent equates to 19.92 inches aft of datum. A MAC of 35 percent equates to 23.86 inches aft of datum. A MAC of 36.7 percent equates to 24.97 inches aft of datum. Aircraft empty weight, including oil: 1,766.0 lb. Pilot weight, plus a parachute: 217.0 lb. Passenger weight, plus a parachute: 174.0 lb. The accident flight, from takeoff to the report of accident, was 39 minutes.

Three estimated CG calculations were performed:

1. If the airplane departed at maximum gross weight, the maximum allowable fuel load would have been 147.6 liters of fuel (234 pounds). At the time of the accident, the airplane would have contained an estimated 105.4 liters of fuel (167 pounds). The estimated weight of the airplane would be 2,324 pounds, with an estimated CG for this configuration of 23.18 inches.

2. If the airplane contained an estimated fuel load of 80 liters (126.8 pounds), the estimated weight of the airplane at the time of the accident would be 2,283.8 pounds, with an estimated CG of 23.44 inches.

3. If the airplane contained the minimum fuel reserve of 17 kg, which is 23.58 liters (37.4 pounds), the estimated weight of the airplane at the time of the accident would be 2,194.4 pounds, with an estimated CG of 24.06 inches.

All of the above examples fall within the allowable CG range data provided by the Yakovlev Design Bureau.

The airplane's canopy consists of a fixed windshield at the front edge of the front seat area, and a common hinged canopy for the front and rear seat occupants. The canopy is latched along the left side of the airplane by forward and rear forks that insert into fuselage mounted locks equipped with release handles. The locks are interconnected by bell cranks, rods, and cables. Unlatching of the lock is accomplished by inward pivoting, and then aft rotation of the handle. Movement of either left-side release handle (front or rear seat) will unlatch both left side canopy locks for opening. Movement of one handle will not produce movement of the other handle.

The canopy is attached to the right side of the fuselage by two hinged plates with forks, one each in the forward and rear seat areas, that insert and latch into fuselage mounted locks equipped with release handles. The right-side canopy handles are painted red and are labeled: "canopy emergency jettison." By interconnection of the fuselage lock mechanisms, inward pivoting, and then aft rotation of either right-side handle will unlatch all canopy locks, and allow the canopy to be jettisoned. Movement of one right handle will not produce movement of any other handle. Inadvertent inward pivoting and aft rotation of the emergency jettison handles is

prevented by installation of soft, copper safety wire, at the base of both right-side canopy handles.

The airplane was equipped with an annunciator module in the front instrument panel. It contained annunciator lights for "CANOPY", "GEN OFF", and "CHIP DET." A separate annunciator module was installed in the rear instrument panel. It contained the same annunciator lights as the front seat, with the addition of "PITOT." Each instrument panel had an additional annunciator for "MAX G."

Examination of the airplane's airframe and engine logbooks revealed a notation that after manufacture, the airplane accrued 1.9 hours at the factory. The wings were removed, and the airplane was shipped to the Northwest Aerobatic Center for reassembly.

The airplane was reassembled on December 5, 1997, in Ephrata, Washington. The pilot registered the airplane with the FAA on May 25, 1998. On June 11, 1998, at 2.2 hours total time since new, the importer of the airplane installed the following items: The rear seat lap belt, the Hobbs hour meter, the smoke system, batteries, transponder and encoder, the aresti clip system, alternator and regulator, and Champion spark plugs with adapters. The airplane was then returned to service.

On June 15, 1998, the airplane received a special airworthiness certificate in the experimental/exhibition category from the Federal Aviation Administration (FAA) Manufacturing Inspection District Office (MIDO), Seattle, Washington. The FAA also issued a list of Exhibition-Group III Aircraft Experimental Operating Limitations for the airplane. The operating limitations included Phase 1, initial flight test restrictions, and Phase II, continuing limitations for operations outside the flight test area. On June 18, 1998, the importer of the airplane completed Phase 1 flight tests after accruing an additional 6.5 hours. A total time of 8.7 hours since new was recorded in the airframe logbook.

The recording hobbs meter was then connected, and the airplane was ferried to Elmendorf AFB for delivery to the pilot. The pilot noted in his logbook that the hobbs meter at delivery was 14.9 hours. The pilot's first flight in the accident airplane was on June 21, 1998. At the time of the accident, the airplane's hobbs meter indicated 29.8 hours, for a total time on the airframe of 38.5 hours. Examination of the maintenance records revealed no additional inspections of the airframe since the airplane completed Phase 1 of the operating limitations criteria.

The engine, a Vedenev M-14X, is a nine-cylinder radial rated at 360 horsepower. It was equipped with a three-bladed wood/composite propeller. At the time of the accident, the engine had accrued 38.5 hours. Examination of the maintenance records revealed no additional inspections of the engine since June 11, 1998; however, the pilot noted in his logbook that the engine oil was changed at a hobbs reading of 24.1.

The pilot based the airplane at the military flying club at Elmendorf AFB. He obtained fuel by pumping from a common fuel pump. The amount of fuel the pilot put in the airplane was not

recorded. The importer of the airplane reported that an average fuel load was between 40 to 50 liters of fuel per wing tank.

Aerobatic airplanes in the Unlimited Class usually have a symmetrical wing with low pitch stability. The wing produces lift equally well upright or inverted. Most do not have any flaps, and usually have high thrust-to-weight ratios.

The YAK-54 is marketed as capable of Unlimited Aerobatics at the World Championship level, designed to maximize response and performance. A marketing brochure states, in part: "...you can pull to vertical at the bottom of the aerobatic box and punch out through the top, rolling all the way, with energy to spare. Connect any two points in the aerobatic box and you can get from one to the other in any attitude you desire, gyrating all the way, with all the power you need to connect another 20 points...and there's energy to spare. Flying a YAK-54, gravity is no longer an obstacle, it's a tool. The kind of precision and artistic style available to YAK-54 pilots is new...it has never been available in such abundance before. Here is an aircraft that will allow you to master perfection...if you have the judgment and skill. The mechanics are there; the question is, are you. This is not a beginner's airplane, but it can take a beginner to the limits of human aerobatic maneuvering, and then over the edge... With the extra seat, it's an ideal aircraft for airshows or for fun flying on the weekend with a friend."

The Yakovlev YAK-52 airplane, an aerobatic airplane previously owned by the pilot, is a two place, low wing primary training airplane with retractable gear. It utilizes the same engine as a YAK-54, but all the flight control characteristics are heavier and slower than the YAK-54. The roll rate for the YAK-54 is 340 degrees per second. The roll rate for the YAK-52 is 140 degrees per second.

METEOROLOGICAL INFORMATION

The closest official weather observation station is Elmendorf AFB, Anchorage, Alaska, which is located 7 nautical miles south of the accident site. On July 26, 1998, at 1055, an Aviation Routine Weather Report (METAR) was reporting in part: Wind, 290 degrees (true) at 5 knots; visibility, 15 statute miles; sky condition and clouds, few at 1,000 feet, 5,000 feet scattered, 7,500 feet broken, 9,500 feet overcast; temperature, 57 degrees F; dew point, 48 degrees F; altimeter, 30.32 inHg.

COMMUNICATIONS/RADAR DATA

Review of the air-ground radio communications tapes maintained by the U.S. Air Force at the Elmendorf Air Traffic Control Tower, disclosed that the accident airplane successfully communicated with the position of local control. No unusual communications were noted between any FAA facility and the accident airplane during the review of the tapes.

The second airplane, the Sukhoi SU-29, N329SU, communicated with the Merrill Field Air Traffic Control Tower (ATCT), and Anchorage Departure Control controllers. A transcript of the

air to ground communications between both airplanes and all involved air traffic control facilities is included in this report.

Continuous Data Recording (CDR) radar data from the FAA's Air Route Traffic Control Center (ARTCC) in Kenai, Alaska, was reviewed by National Transportation Safety Board investigators. The Kenai radar facility is 64.5 nautical miles south of the accident site. Due to the distance from the radar site, and terrain features around R-2203, radar personnel at the ARTCC said that radar coverage in the area of the accident does not reach to the surface. The ARTCC radar has a radar sweep every 12 seconds.

Radar data from the accident airplane was recorded at altitudes that varied between 3,400 to 2,600 feet. The last recorded altitude, about 1.5 minutes before the airplane crashed, was 2,900 feet.

A copy of the radar data is included in this report. Also, see attached radar data graphs.

AERODROME AND GROUND FACILITIES

The accident occurred in a wooded area of the U.S. Army's Fort Richardson Military Reservation. This area of the reservation, known as the Malemute drop zone, includes an emergency military airstrip that usually is utilized for airborne military exercises. The airstrip is oriented north/south. The airspace, restricted area R2203, is controlled by the Anchorage Approach Control. The airspace was not restricted at the time of the accident.

WRECKAGE AND IMPACT INFORMATION

The NTSB IIC, accompanied by two other NTSB investigators, FAA personnel, and U.S. Air Force personnel (listed as parties to the investigation), examined the airplane wreckage at the accident site on July 26, 1998.

All of the airplane's major components were located at the main wreckage area. The airplane was found in a nose down, inverted attitude at the base of a large tree. The tree had broken branches and scraping of the bark, beginning about 30 feet above the ground. Numerous trees surrounding the scene did not have any broken limbs.

The nose of the airplane, including the propeller assembly and engine, was buried in the ground. The upper engine cowling, the fuselage firewall, and the engine were crushed aft about 25 degrees from the forward edge of the windshield to the propeller hub. The main fuselage spar web was bent to the right about 20 degrees. The left, vertical side of the fuselage, adjacent to the rear seat, was fractured and torn. The top, right edge of the empennage, from the rear seat to the vertical stabilizer, was buckled to the left.

The right wing had extensive spanwise leading edge aft crushing with more crushing evident along the upper side of the leading edge. A slight depression along the ground was noted

adjacent to the full span of the right wing leading edge. The inboard, trailing edge of the wing and aileron, still attached to the wing, was bent/buckled upward. The right aileron spade was broken from the lower surface and located about 25 feet north of the fuselage point of rest. The right wing fuel tank was crushed. Fuel was observed draining from the ruptured tank.

The left wing displayed aft semi-circular crushing of the leading edge about 3 1/2 feet inboard from the tip, and a second aft impact about 6 1/2 feet inboard from the tip. Both impact areas were crushed aft to the wing spar. Both areas of impact crushing had portions of tree limbs imbedded in the leading edge. The inboard, trailing edge of the wing was bent/buckled upward. The wing and aileron, still attached to the wing, had slight upward chordwise buckling, about midspan. The forward, and outboard end of the left wing fuel tank was peeled outboard. Fuel was observed in the ruptured tank. The left aileron spade was attached to the aileron.

The empennage was twisted to the right. The elevator remained attached to the stabilizer. The outboard end of the right horizontal stabilizer displayed aft and downward crushing of the leading edge. The right elevator had similar damage, and was buckled at the inboard trailing edge. The right horizontal stabilizer and the right elevator were buckled downward about midspan approximately 45 degrees. The left horizontal stabilizer, the left elevator, and the vertical stabilizer appeared undamaged. The rudder remained attached to the vertical stabilizer. It had an area of aft crushing, and right deformation of the leading edge, adjacent to the aft fuselage bulkhead.

The elevator trim tab was attached to the trailing edge of the right elevator. The trim tab control rod was attached to the tab. The trim control rod was attached to a fuselage mounted bell crank. Cables to the bell crank from the rear seat trim control handle have swedged ends that fit into slots on the upper and lower end of the bell crank. The upper end of the trim cable was not retained in its slot.

Wood bark and splinters were embedded along the front edge of the front seat instrument panel. Wood splinters were embedded along the upper right edge of the rear seat instrument panel. Wood bark and splinters were embedded in the upper right portion of the forward canopy frame.

The lower end of the airplane canopy forks (left and right side) were retained in their respective fuselage locks, but were sheared at the upper edge of the fuselage where the canopy latched to the fuselage. The canopy frame was shattered and broken. It was sheared from the fuselage, located on the ground to the right side, and adjacent to the cockpit area of the inverted fuselage. The rear seat emergency jettison handle had copper safety wire attached to the handle.

The right side of the front seat instrument panel, and the right side of the fuselage structure adjacent to the front seat emergency jettison handle, was crushed and distorted. Copper safety wire, normally attached to the front seat emergency jettison handle, was not located. No evidence was discovered of egress, or attempted egress, from the cockpit.

Flight control system continuity was established to the point of impact related damage. The aileron control bell crank was fractured at its attach point to the upper longitudinal control shaft under the front seat. The left wing aileron control summing bell crank link was attached to the airframe. The outboard end of the link was still bolted to the summing bell crank, but the attach point on the bell crank was fractured.

The lower longitudinal control shaft, consists of three segments. One connects the front and rear control sticks together. A second control rod runs aft to an intermediate bell crank mounted on an aft airframe bracket. A third control rod runs from the bell crank to the elevator input bracket. The threaded portion of the aft rod end bearing of the second elevator control shaft, where it attached to the bell crank, was fractured.

The rear bracket for the upper longitudinal flight control shaft, located under the rear seat, was bent aft in a slight "U" shape. The rear support bearing for the upper longitudinal control shaft was fractured. The entire upper longitudinal control shaft was displaced aft. The forward pivot was pulled aft out of its forward support bearing.

The rear bracket and bearing for the longitudinal flight control shaft, the aileron control bell crank, the left wing aileron control summing bell crank link, and the aft elevator control shaft and rod end bearing, were removed for examination by the Safety Board's Materials Laboratory for examination. The examination indicated all fracture surfaces exhibited overload signatures.

The airplane's rudder pedals for the front and rear seats are adjustable for length. They are connected to their respective rudder control quadrant by push/pull tubes. The aft rudder control quadrant was undamaged. The push/pull tubes from the rear pedals to the aft rudder control quadrant were attached at their respective points and buckled about mid-shaft. The cable attachments from the rear rudder control quadrant to the forward rudder control quadrant, and the cable attachments to the rudder control bracket were undamaged.

The front rudder control quadrant, installed just aft of the firewall, received impact damage at the right side of the casting. The cables to the rear rudder control quadrant were attached. The rudder pedals were crushed upward and aft, under the instrument panel. The push/pull tubes from the front pedals to the front rudder control quadrant were buckled and bent. The left side push/pull tube rod end bearing was fractured.

Each rudder pedal was equipped with a leather strap and buckle utilized to secure the pilot's foot to the pedal during inverted flight. In the rear seat, the left foot strap was buckled but broken. The right foot strap was buckled and unbroken. In the front seat, both straps were buckled and unbroken.

The propeller hub assembly remained connected to the engine crankshaft. One propeller blade was broken/shattered from the hub in an aft direction. It was crushed aft over the top of the

engine cylinders and upper fuselage cowling. A second propeller blade was broken from the hub. A third blade remained attached to the hub, and was partially buried in the ground. The propeller governor was broken from the front face of the engine case.

The engine sustained impact damage to the upper, front portion of the engine. The number one cylinder received impact damage to the push rods. The engine motor mounts were broken, and the engine was displaced aft and to the right. The crankshaft could be rotated by the propeller. Gear and valve train continuity was established. Thumb compression in each cylinder was noted when the crankshaft was rotated by hand. The exhaust tubes, predominately on the upper right side of the engine, were crushed, bent, and folded, producing sharp creases that were not cracked or broken along the creases.

The firewall mounted gascolator was crushed. The internal screen was crushed and torn, but was free of contaminants.

The magnetos sustained impact damage, and both were broken away from the engine case.

The carburetor remained attached to the bottom of the engine. Removal of the fuel inlet screen revealed the presence of fuel. The screen was free of contaminants.

The engine driven fuel pump was broken away from the case. A small amount of fuel was contained in the pump. The pump could be rotated by hand. The engine driven air pump was broken away from the case.

The engine oil tank was crushed and punctured. The smoke oil tank was crushed and punctured.

MEDICAL AND PATHOLOGICAL INFORMATION

A postmortem examination of the pilot, and the passenger, was conducted by U.S. Armed Forces Institute of Pathology personnel, under the authority of the Alaska State Medical Examiner, 5700 E. Tudor, Anchorage, Alaska. The postmortem examination for the pilot was conducted on July 28, 1998. A postmortem examination of the passenger was conducted on July 29, 1998. The examinations revealed the cause of death for the pilot and passenger were blunt force trauma.

Additionally, the postmortem examination of the pilot disclosed contusions, and lacerations to the back of the left hand, lacerations to the back of the right hand, fractures of the right hand and wrist, and a fracture of the right foot.

The postmortem examination of the passenger also revealed contusions and lacerations to the back of the left hand, abrasions to the palm of the left hand, lacerations to the back of the right hand, a laceration of the right palm, a dislocated finger on the right hand, and a laceration to the bottom of the right foot.

A toxicological examination of the pilot indicated the presence of salicylates and acetaminophen. A toxicological examination of the passenger was negative.

TESTS AND RESEARCH

On August 19, 1998, the engine was examined at Alaskan Aircraft Engines, Anchorage. The parties noted in this report participated in the examination. The examination discovered no evidence of preimpact mechanical malfunction.

A functional test of the magnetos and wiring harness produced spark at all terminals.

The fine wire sparks plugs had a dry, gray appearance.

The engine oil sump screen was free of contaminants. The presence of oil was noted throughout the engine.

The oil pump had light rotational scoring on the internal surfaces of the pump housing.

The mechanical fuel pump was broken away from the engine case. The interior vanes of the pump were undamaged. The pump could be rotated by hand.

The fuel shutoff valve was found in the open position.

The carburetor sustained minor impact damage. The venturi and nozzle were unobstructed. The carburetor inlet fuel screen was free of contaminants. Fuel was in the fuel inlet line, and the accelerator pump. A small screen in the carburetor bowl was clean and unobstructed. Fuel was in the bowl.

The front seat instrument panel annunciator modules were removed, and sent to the Safety Board's Materials Laboratory for examination. The examination revealed the "MAX G" annunciator bulb filaments were stretched and deformed.

The rear seat instrument panel annunciator modules were removed and examined. The examination revealed the annunciator bulb filaments were not stretched.

ADDITIONAL INFORMATION

The FAA defines aerobatic flight as an intentional maneuver involving an abrupt change in an aircraft's attitude, an abnormal attitude, or abnormal acceleration, not necessary for normal flight. The FAA limits where aerobatics may be conducted. The limits include prohibition of aerobatics over any congested area, and below 1,500 feet above the ground. The FAA requires occupants of airplanes to wear an approved parachute when performing maneuvers that exceed a bank angle of 60 degrees, or a nose-down, or nose-up, attitude of more than 30

degrees. Providing all occupants wear a parachute, there is no prohibition against carrying passengers during aerobatic flight.

The FAA requires additional pilot training for operating a complex airplane (an airplane with retractable landing gear, flaps, and a controllable pitch propeller), and additional pilot training for operating a high performance airplane (an airplane with an engine of more than 200 horsepower). The FAA does not require additional pilot training for aerobatic flight. The FAA does require a Statement of Aerobatic Competency (FAA Form 8710-7) if a pilot is participating in an FAA authorized aviation event.

According to the FAA's Flight Training Handbook, a spin is described as an aggravated stall that results in "autorotation", wherein an airplane follows a corkscrew path in a downward direction. When an airplane's angle of attack is excessive enough to produce a stall, the airplane's nose will pitch down. If any adverse yaw is present, one wing will usually drop, and an autorotation begins. Airplane spins are categorized as normal upright, normal inverted, flat upright, flat inverted, and may be classified as normal or accelerated. The FAA's standard spin recovery sequence for a normal, upright spin, is to 1) reduce engine power, 2) apply opposite rudder to slow the rotation, 3) apply positive forward elevator movement to reduce the angle of attack and break the stall, 4) neutralize the rudder as spinning stops, and, 5) return to level flight.

In the September, 1996, issue of Sport Aerobatics Magazine (the publication of the International Aerobatic Club), the author of an article titled "Inverted Spinsations", discusses the possibility that during the recovery from a normal, upright, spin, it is possible to move the elevator control aggressively forward, beyond the neutral position. The author states this may produce a "crossover" spin where the airplane moves from an upright attitude, to an inverted attitude. The author said the crossover transition from an upright spin to an inverted spin, may be disorienting. The airplane will still appear to rotate the same direction as an upright spin, but the airplane's YAW from an upright spin to an inverted spin is now opposite.

The airplane's flight manual indicated an involuntary entry into an inverted spin may occur during an incorrect performance of a wing-over, loop, immelman turn, chandelle, or combat turn. The flight manual states the recovery technique for a normal, inverted, spin is to reduce engine power, pull the control stick backward 1/4 travel from the neutral position, and apply opposite rudder to the direction of yaw.

The demonstration pilot who provided the accident airplane pilot with a checkout, has accrued about 2,000 hours total time. Of those 2,000 hours, approximately 1,400 hours are aerobatic flight time, with about 250 hours in the YAK-54. He has flown the Yak-54 airplane through extensive aerobatic maneuvers. The demonstration pilot said that due to the lightness of the controls, the YAK-54 can easily be over-controlled, and during the recovery from an upright spin, can inadvertently be transitioned into an inverted spin.

An emergency spin recovery technique, known as the Beggs Maneuver, often utilized to stop

an aerobatic airplane from spinning, consists of, power to idle, an application of opposite rudder, and letting go of the control stick. Following the accident, the importer of the airplane said that the demonstration pilot (who checked out the accident pilot), performed several spins in another YAK-54 airplane to explore the spin characteristics, and use of the Beggs maneuver. The demonstration pilot reported that with one pilot in the rear seat (230 pounds), and 80 liters of fuel on board (126.8 pounds), the airplane would recover by utilizing the Beggs maneuver. With 50 liters of fuel (79.25 pounds), the Beggs maneuver in the YAK-54 did not stop the airplane from spinning. The demonstration pilot did not attempt the Beggs maneuver with two persons on board.

Using the above fuel weights and the demonstration pilot's weight, the accident airplane's estimated center of gravity was calculated for the above listed conditions with one pilot in the rear seat. With 80 liters of fuel (Beggs maneuver effective), the airplane's CG was estimated to be 22.30 inches. With 50 liters of fuel (Beggs maneuver ineffective), the airplane's CG was estimated to be 22.62 inches. (See comparison of CG calculations contained in the AIRCRAFT INFORMATION section of this report. Note CG calculations of the accident airplane included two pilots).

At the time of the accident, the Federal Aviation Administration (FAA) did not have any agreement with the Government of Russia for issuing a U.S. aircraft type certificate under 14 CFR Part 21.29, to a Russian aircraft. Aircraft from Russia can be imported as experimental/exhibition aircraft under Part 21.191. The process for importation is specified in FAA Orders 8300.10, 8310.2, and 8130.27. FAA Order 8130.27 provides information and guidance to Aviation Safety Inspectors for the certification and operation of aircraft under the experimental purpose(s) of research and development, exhibition, and/or racing, and the issuance of special flight authorization for non U.S. aircraft.

The FAA divides experimental/exhibition aircraft into four groups. Group I, Performance Competition Aircraft (powered and nonpowered), are described as specialty aircraft of limited availability, suitable for competition, and not utilized for personal business or transport activity, such as the Pitts Special, the Sukhoi SU-26, and the Sukhoi SU-29. Group II aircraft are turbine powered. Group III aircraft are piston powered warbirds, vintage, replica, and unique aircraft, such as the North American T-28 and P-51, Lockheed P-38, Boeing B-17, and the de Havilland DHC-1 Chipmunk. Group IV aircraft are all others including Supplemental Type Certificate (STC) modifications, aircraft over 12,500 pounds or those having four or more seats, and any newly produced aircraft without a type certificate.

FAA Order 8130.27 specifies that an exhibition could be a wide range of activities, but would include organized airshows, organized air races, organized fly-ins and exhibitions, youth education programs, shopping mall/school, or similar static displays, organized aerobatic competition, and movie or television productions. The FAA further clarifies that an exhibition, described under Part 21.191 (d), was not intended to allow for the brokering or marketing of experimental aircraft.

Applicants for an experimental/exhibition airworthiness certificate are required to submit an application, along with a program letter setting forth the purpose for which the aircraft will be used. The letter must be specific, including airshows, races, exhibitions, etc., in which the aircraft will participate. The letter should state a reasonable schedule of events to be attended, but should not list events obviously impossible to attend (e.g., listing all airshows in the U.S.).

FAA, Manufacturing Inspection District Offices (MIDOs), have the responsibility for the airworthiness certification of import/export aeronautical products. The MIDO may delegate this responsibility to a Flight Standards District Office (FSDO). The accident airplane was issued a special airworthiness certificate in the experimental/exhibition category from the Seattle, Washington, MIDO on June 15, 1998. The MIDO also issued a list of Group III operating limitations, including Phase 1 (initial flight test restrictions), and Phase II (continuing limitations for operations outside the flight test area).

After importation of the airplane from Russia on December 5, 1997, the Northwest Aerobatic Center completed Phase 1 of the operating limitations criteria on June 18, 1998.

The FAA requires the Phase 1 and Phase II operating limitations be conducted in accordance with 14 CFR Part 91.319, Aircraft having Experimental Certificates; Operating Limitations. Part 91.319 (b), specified in Phase 1, states that no person may operate an aircraft with an experimental certificate outside the area assigned by the FAA until it is shown the "aircraft is controllable throughout its normal range of speeds and throughout all the maneuvers to be executed, and the aircraft has no hazardous operating characteristics or design features." FAA airworthiness personnel do not evaluate an experimental aircraft's characteristics or it design features. The FAA relies on a pilot to attest to the aircraft's flight characteristics. Part 91.319 (e), specified in Phase II, states the FAA may prescribe additional limitations that are considered necessary, including limitations on the persons that may be carried in the aircraft.

WRECKAGE RELEASE

The Safety Board released the wreckage, located at Anchorage, to the owner's representatives on January 11, 1999.

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	53,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Rear
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane single-engine; Instrument airplane	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 Valid Medical--w/ waivers/lim	**Last FAA Medical Exam:**	February 26, 1998
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	6000 hours (Total, all aircraft), 17 hours (Total, this make and model), 5813 hours (Pilot In Command, all aircraft), 43 hours (Last 90 days, all aircraft), 23 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Yakovlev	**Registration:**	N354AM
Model/Series:	YAK-54 YAK-54	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Experimental (Special)	**Serial Number:**	02003
Landing Gear Type:	Tailwheel	**Seats:**	2
Date/Type of Last Inspection:	June 15, 1998 Annual	**Certified Max Gross Wt.:**	2391 lbs
Time Since Last Inspection:	36 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	39 Hrs	**Engine Manufacturer:**	Vendeneyev
ELT:	Not installed	**Engine Model/Series:**	M-14X
Registered Owner:	RED EAGLE FLYING, LLC	**Rated Power:**	360 Horsepower
Operator:	DAVID J. MCCLOUD	**Operating Certificate(s) Held:**	None
Operator Does Business As:		**Operator Designator Code:**	

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	EDF ,213 ft msl	**Distance from Accident Site:**	7 Nautical Miles
Observation Time:	11:16 Local	**Direction from Accident Site:**	193°
Lowest Cloud Condition:	Scattered / 1000 ft AGL	**Visibility**	15 miles
Lowest Ceiling:	Broken / 7500 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots / None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	350°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30 inches Hg	**Temperature/Dew Point:**	57°C / 48°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	(EDF)	**Type of Flight Plan Filed:**	None
Destination:		**Type of Clearance:**	None
Departure Time:	10:30 Local	**Type of Airspace:**	Restricted area

Airport Information

Airport:		**Runway Surface Type:**	
Airport Elevation:		**Runway Surface Condition:**	
Runway Used:	0	**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	2 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Fatal	**Latitude, Longitude:**	61.160072,-149.989517(est)

Administrative Information

Investigator In Charge (IIC):	Erickson, Scott
Additional Participating Persons:	DAVE MCGLOTHLEN (FAA); ANCHORAGE , AK CAPT VINCE V WILD (USAF); ELMENDORF AFB , AK
Original Publish Date:	March 24, 2000
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=43537