

Air Show Accident Review: What Went Wrong?

Civil Aerospace Medical Institute

Medical Research Team

Presented to: Patty H. Robertson M.D. Aerobatic
and Aviation Safety Symposium

By: Nicholas L. Webster M.D., M.P.H.

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**Federal Aviation
Administration**



Acknowledgements

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- **Dr. Bill Bush** (data analysis)
 - Former Navy S-3 pilot, Naval flight surgeon
 - AME working at Squadron 51
 - Currently owns N3N and WILDCAT
- **Mr. D Smith** (Oshkosh accident analysis)
 - Former Army Helicopter Pilot
 - Transportation Safety Institute (TSI) instructor



Introduction

- **Analysis of Civilian Air Show Accidents**
(1997 –2007)
 - review current regulation and guidance governing air shows
 - Update the review civilian accidents to identify hazardous trends include more recent accidents
- **Review recent Air Show accidents and NTSB probable cause**



Air Show Coordination Requirement

- **FAA Order 8900.1 Flight Standards Information Management System (FSIMS)**
 - **Volume 3** *General Technical Administration, Chapter 6 Issue a Certificate of Waiver or Authorization for an Aviation Event* Date: 9/13/07
 - This chapter's task is to determine whether to issue a Federal Aviation Administration (FAA) Form 7711-1, Certificate of Waiver or Authorization, to an applicant for an aviation event. Completion of this task results in the issuance of a certificate of waiver or authorization or the disapproval of FAA Form 7711-2, Application for Certificate of Waiver or Authorization.

<http://fsims.faa.gov/PICResults.aspx?mode=Publication&doctype=8900.1>



Performer Requirements

- **5-1549 AEROBATIC COMPETENCY.**

- In order for a pilot of a civil aircraft to perform aerobatic and certain other maneuvers at air shows authorized by FAA Form 7711-1, Certificate of Waiver or Authorization, the pilot must have a valid FAA Form 8710-7, Statement of Acrobatic Competency, or a Transport Canada Form 26-0307, Statement of Aerobatic Competency, in his/her possession.

- **FAA Order 8900.1 Flight Standards Information Management System (FSIMS) VOLUME 5**
AIRMAN CERTIFICATION, CHAPTER 9 OTHER AIRMEN AUTHORIZATIONS, Section 1 Issue/Renew/Rescind a Statement of Acrobatic Competency

http://fsims.faa.gov/wdocs/8900.1/v05%20airman%20cert/chapter%2009/05_009_001rev1.pdf



FAA - Industry Safety Coordination

- **5-1549 AEROBATIC COMPETENCY.**
 - **C. Aerobatic Flight Demonstration**
 - Individuals requiring a Statement of Aerobatic Competency will be referred to an industry evaluator such as those designated by the International Council of Air Shows, Inc. (ICAS) or the Experimental Aircraft Association (EAA) Warbirds of America. An ***aerobatic competency evaluator*** (ACE) will forward a written recommendation to the FAA district office through the appropriate organization. The ACE will also recommend standard limitations to an individual's Statement of Aerobatic Competency based upon observed performance (figure 5-166).
 - **FAA Order 8900.1 Flight Standards Information Management System (FSIMS) VOLUME 5**
AIRMAN CERTIFICATION, CHAPTER 9 OTHER AIRMEN AUTHORIZATIONS, Section 1 Issue/Renew/Rescind a Statement of Acrobatic Competency

http://fsims.faa.gov/wdocs/8900.1/v05%20airman%20cert/chapter%2009/05_009_001rev1.pdf



Aerobatic Safety Guidance

- **Advisory Circular (AC) 91-48**
 - SUBJECT: ACROBATICS - PRECISION FLYING WITH A PURPOSE
 - PURPOSE. - This advisory circular provides information to persons who are interested in acrobatics to improve their piloting skills as recreation, sport, or as a competitive activity. It also discusses Federal Aviation Regulations (FAR) pertaining to acrobatic aircraft airworthiness, considerations, acrobatic instruction, operations, and acrobatic flight safety.



Aviation Medical Information

- **Advisory Circular (AC) 91-61**

- SUBJECT: A HAZARD IN AEROBATICS: EFFECTS OF G-FORCES ON PILOTS

- “1. PURPOSE. Because acrobatic flying subjects pilots to gravitational effects (G's) that can impair their ability to safely operate the aircraft, pilots who engage in aerobatics, or those who would take up such activity, should understand G's and some of their physiological effects. This circular provides background information on G's, their effect on the human body and their role in safe flying. Suggestions are offered for avoiding problems caused by accelerations encountered in acrobatic maneuvers.”



Aviation Medical Information

- **Aeronautical Information Manual - Official Guide to Basic Flight Information and ATC Procedures**
 - Chapter 8–1–7. Aerobatic Flight
 - Discussion of physiological stresses associated with ***accelerative*** forces during aerobatic maneuvers.



Accident Review

- **Accidents were identified between 1997 and 2007 using data obtained from the International Council of Air Shows (ICAS) and the National Transportation Safety Board (NTSB)**
- **ICAS provided a list of air show performer, air show and practice accidents 1997 to 2004**
- **NTSB accident database was searched by word and business code for “air show”, “airshow” and “air race”**



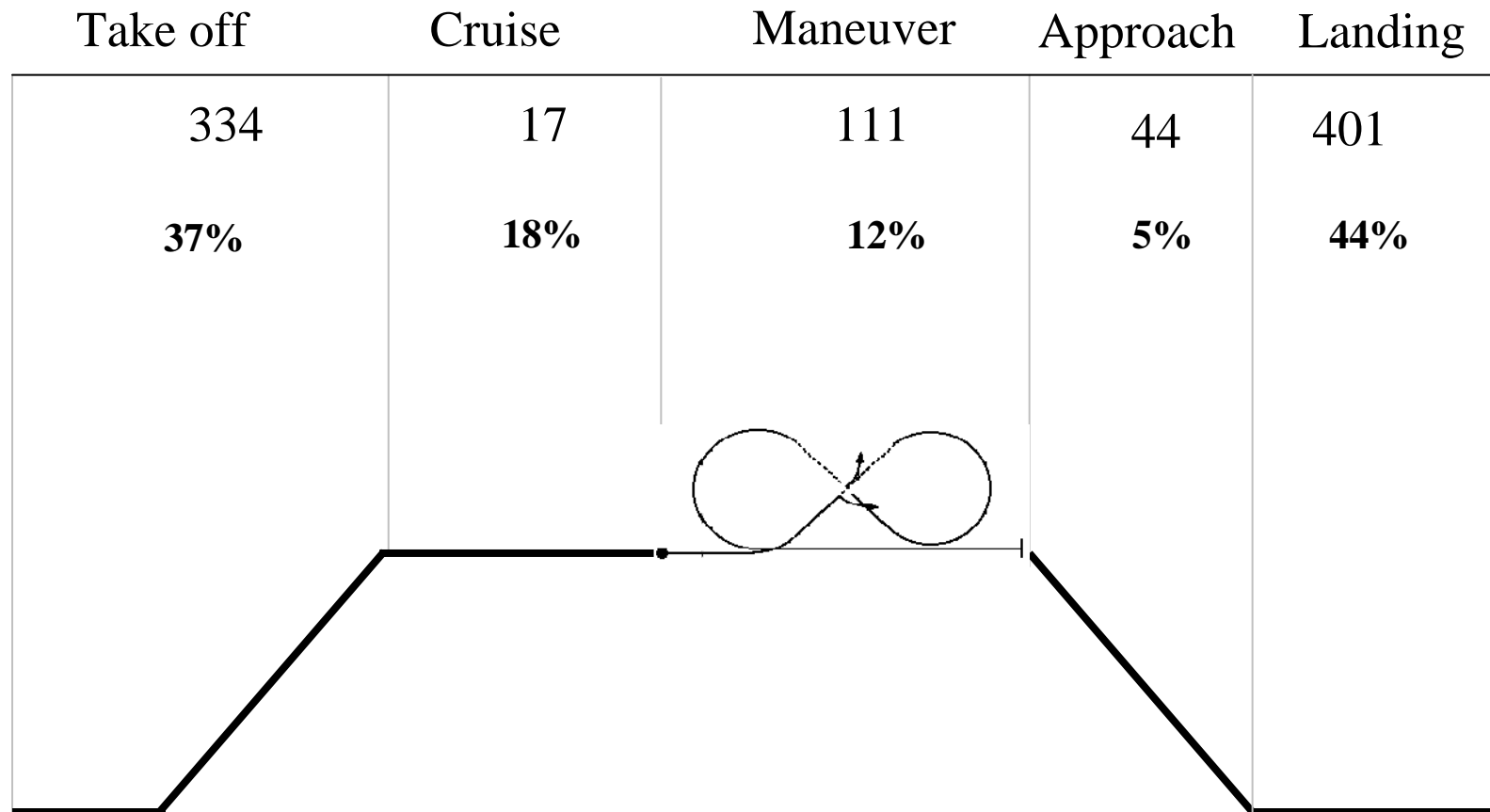
Air Show Accidents 1997 - 2007

- **55 air show and practice accidents**
 - 36 air show accidents
 - 26 fatal accidents (72%) resulting in 30 fatalities
 - 19 practice accidents
 - 13 fatal accidents (68%) resulting in 18 fatalities
 - 39 fatal accidents with 48 fatalities



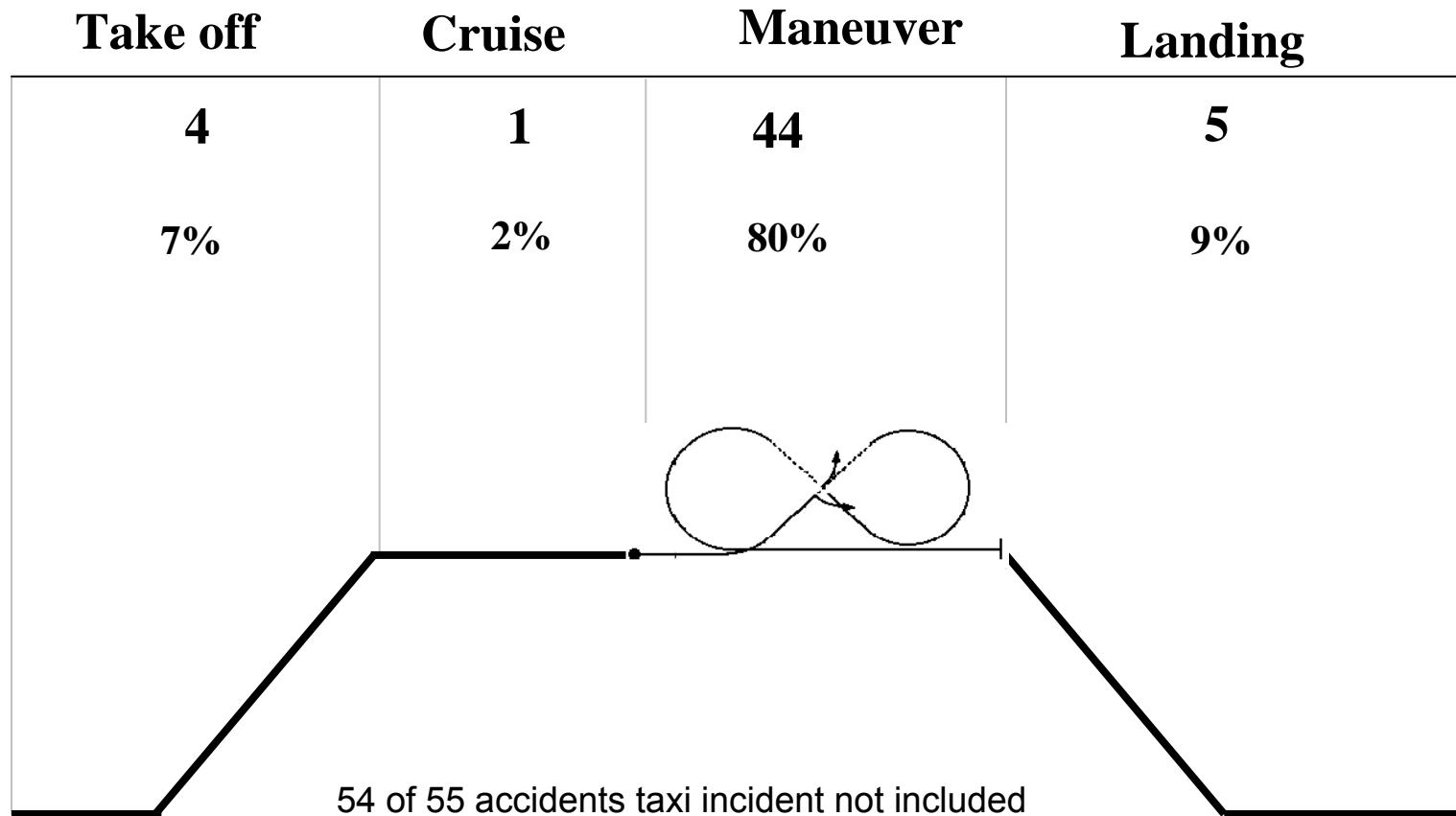
Pilot-Related General Aviation Accidents by Phase of Operation

(Extracted from 2004 NALL Report)



Air Show Accidents by Phase of Operation

1997-2007



Examples of Gyroscopic Maneuvers

- **Maneuvers that primarily stimulate the semicircular canals of the vestibular system**
 - Vertical – high yaw rate, spin, spiral maneuver
 - Horizontal – rolls



Vertical - spin, spiral, or yaw maneuver preceded accident

- October 02, 2004 Santa Fe Municipal Airport (SAF), Santa Fe, New Mexico
- Sukhoi SU-29
- Performing a torque roll – inverted spin
- Witness stated, "He came off the throttle, the rotation stopped, then the airplane yawed. I heard the engine come in. The airplane came around in a positive attitude. He was getting low. He was upright in a spin. He went to full power. He made a turn and a half and then hit [the ground]."
- Pilot suffered fatal injuries



Horizontal - roll preceded accident

- September 13, 2003 Moffett Federal Airfield, Mountain View, California
- Aviat Pitts S-2C aerobatic biplane
- Low altitude slow rolls, about 35 feet above ground level (AGL), the left wing contacted the runway
- Pilot sustained minor injuries



Examples of \pm Gz Maneuvers

- **Maneuvers that primarily stimulate the otolith organs of the vestibular system**
 - Vertical - loops
 - Horizontal – turns

<http://www.neuroanatomy.wisc.edu/virtualbrain/BrainStem/13VNAN.html>



Vertical – loop preceded accident

- March 22, 2003, Tyndall Air Force Base, Panama City, Florida
- Technoavia SP-95
- Looping maneuver commencing at 50 feet
- Climbed to an altitude of about 300 feet, and at the top of the maneuver it appeared to have stalled
- Descended in a level attitude with a high rate of descent and impacted the ground
- Pilot suffered fatal injuries


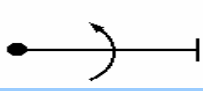

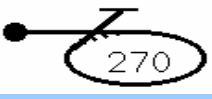




Horizontal – turn preceded accident

- September 29, 2002 Pickaway County Memorial Airport (CYO), Circleville, Ohio
- North American AT-6D
- Witness stated “The accident airplane made a steep turn of 60 degrees or more, then leveled out and was heading southeast when it went up and left wing over (in a stall) configuration. The airplane then descended, almost vertical into the ground.”
- Pilot suffered fatal injuries



Maneuver Performed Prior to 44 Maneuvering Accidents

							
Unknown	Vertical maneuver with yaw, spin, spiral	Horizontal rolls	Vertical G - loops	Horizontal G - Turns	Material Failure	Wings Level Midair	Low Level CFIT
1	7	10	11	4	6	2	3
	Gyroscopic Maneuvers		+/- Gz Maneuvers				
	17		15				

Discussion

- **Maneuvering in close proximity to the ground poses a significant hazard to airshow pilots**
- **Safety zones and operational restrictions directing aircraft energy away from audiences has protected the public in the event of an airshow accident.**



Conclusions

- **This study shows that the maneuvering phase of flight in air show performances continues to be the most hazardous**
- **This study indicates that, in this series, rolling, spinning, yawing maneuvers pose as much of a hazard as $\pm G_z$ maneuvers**
 - in the low-altitude arena of air shows, maneuvers that effect the semicircular canals of the vestibular system (the aviator's gyro) pose a similar hazard to those that effect the otoliths (the aviators linear accelerometers)

2005 Accident Summary

Date	Injury level	Aircraft	Location	Summary	NTSB Probable Cause
6/25/2005	Fatal 1	One Design	Madras, OR	Practice - At 1500 feet entered flat spin stopped spin an low altitude	The pilot's failure to maintain altitude/clearance from terrain while performing aerobatics which resulted in a collision with the ground.
7/10/2005	Fatal 2	Carlstrom Long EZ & Morgan RV-8	Lewes, DE	Practice - "Six ship Opposing" following pass of 2 groups of 3 Long EZ collided with lead RV-8	The Long EZ pilot's failure to maintain clearance from the RV-8 airplane, which resulted in a mid-air collision during a formation flight.
7/23/2005	Fatal 1	Yak 52	Claremore, OK	Show - intentional role to low altitude inverted flight following takeoff hit runway inverted	The pilot's failure to obtain adequate airspeed while executing a low altitude aerobatic maneuver, which resulted in an aerodynamic stall while inverted. A factor was the low altitude.
7/26/2005	Fatal 1	North American F-51D	Malone, WI	Show - Holding for show doing lazy eight maneuver, lost control	The pilot not maintaining aircraft control and clearance from terrain for undetermined reasons during a low level maneuver.



2006 Accident Summary

Date	Injury level	Aircraft	Location	Summary	NTSB Probable Cause
7/16/2006	Fatal 1	Hawker Siddeley Hunter MK 58A	Hillsboro, OR	Show Take off turned for fly-by lost altitude at midfield and crashed	Pending
7/30/2006	Fatal 1	Grumman TBM-3 Avenger & Vans Aircraft RV-6	Oshkosh, WI	Taxi Avenger taxied over RV-6	The Avenger pilot's visual lookout was inadequate and he failed to maintain clearance from the RV-6. Contributing factors were the Avenger's restricted visibility and the RV-6.
8/16/2006	Serious 1	Extra 300	Mojave, CA	Practice - Vertical maneuver - loop impacted ground nose down	Pending
10/4/2006	Fatal 1	Extra 300	Tucumcari, NM	Show- Square loop impacted ground following stall on pullout	The pilot's failure to maintain aircraft control during aerobatic flight, resulting in an inadvertent accelerated stall. Contributing factors include the low altitude for recovery from the loop and the high density altitude.
10/14/2006	Fatal 1	Extra 300	Culpeper, VA	Show - Multiple snap rolls on a 45 deg down-line hit ground	Pending



2007 Accident Summary

Date	Injury level	Aircraft	Location	Summary	NTSB Probable Cause
3/14/2007	Uninjured 1	Pietsch IT	Douglas, AZ	Practice - rudder cable disconnected due to chafed safety wire	Loss of directional control during landing due to separation of the rudder cable. A factor was the soft dirt terrain.
3/16/2007	Fatal 1	Aero Vodochody L-39C	Titusville, FL	Show - Jet performing loop penetrated clouds, rolled on descent impacted ground	Pending
5/2/2007	Serious 3 Minor 2	Grumman S-2B	Cherry Point, NC	Show - Lost power hit power lines	Pending
7/13/2007	Uninjured 1	Fokker D VII	Geneseo, NY	Practice -Lost power on Takeoff	Pending
7/27/2007	Fatal 1 Uninjured 1	Beck P-51A & North American P51-D	Oshkosh, WI	Show - Landing following air race demo Beck P-51A hit P-51D on landing	Pending
7/28/2007	Fatal 1	S2S Pitts Special	Dayton, OH	Show - Pilot failed to recover from intentional spin	Pending
9/7/2007	Fatal 1	SNJ-2	Virginia Beach, VA	Practice - SNJ-2 was dash 5 in a 5 plane pop-up break following demonstration. Failed to break and flew wings level into ground.	Pending



Safety starts on the ground

- **NTSB Identification: CHI06FA206A**
07/30/2006 Oshkosh, WI
 - Aircraft: Grumman TBM-3 and RV-6, registration: N420GP Injuries: **1 Fatal** 3 Uninjured



NTSB Report

- On July 30, 2006 at 1207 central daylight time, an amateur-built RV-6 sustained substantial damage when a Grumman TBM-3, Avenger taxied into the empennage and fuselage of the RV-6.
- The **passenger** seated in the right seat of the RV-6 was **killed** but the RV-6 pilot, the pilot and passenger of the Avenger were not injured.













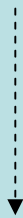




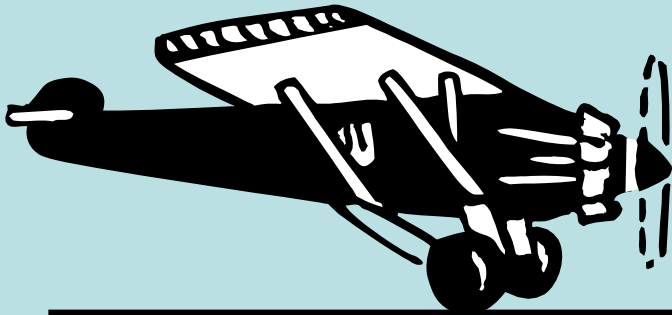
Active Runway



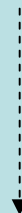
War Bird Parking



TMB-3 Avenger



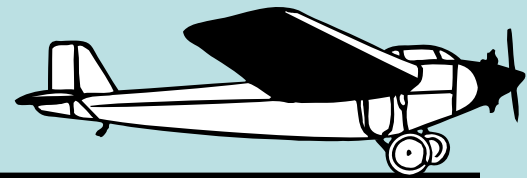
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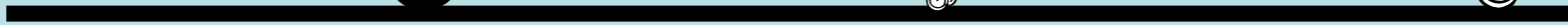
RV-6



TUNDRA



Papa Taxi Way

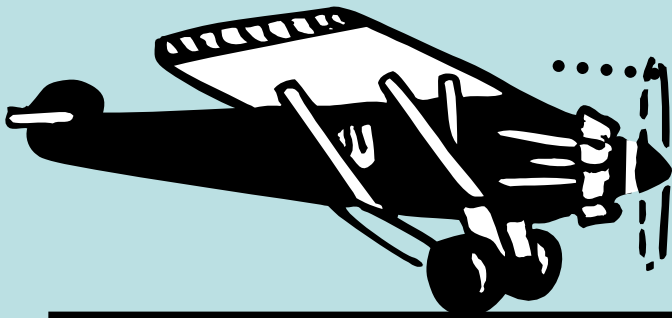




Active Runway



TMB-3 Avenger



TUNDRA

RV-6



Papa Taxi Way

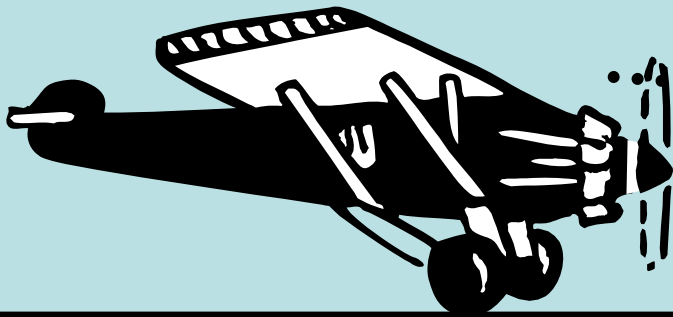




Active Runway



TMB-3 Avenger



TUNDRA

RV-6

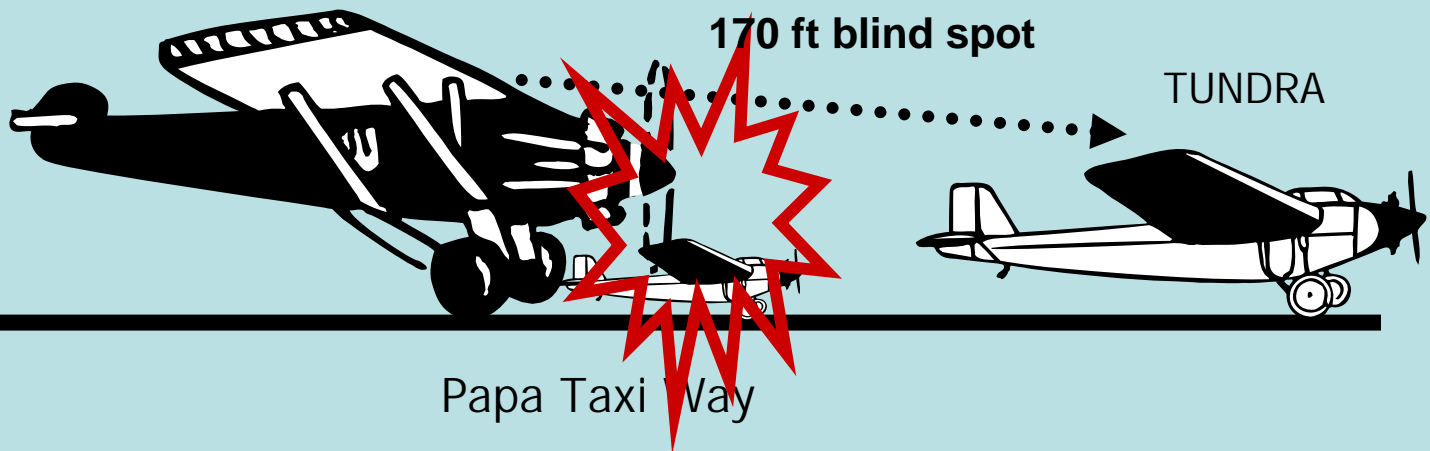


Papa Taxi Way





Active Runway



NTSB Probable Cause (7/25/07)

- **The Avenger pilot's visual lookout was inadequate and he failed to maintain clearance from the RV-6.**
- **Contributing factors were the Avenger's restricted visibility and the RV-6.**



High density altitude performance

- **NTSB Identification: DEN07FA003**
10/04/2006 Tucumcari, NM
 - Aircraft: Extra Flugzeugbau GMBH EA 300/L,
registration: N300BB Injuries: **1 Fatal**



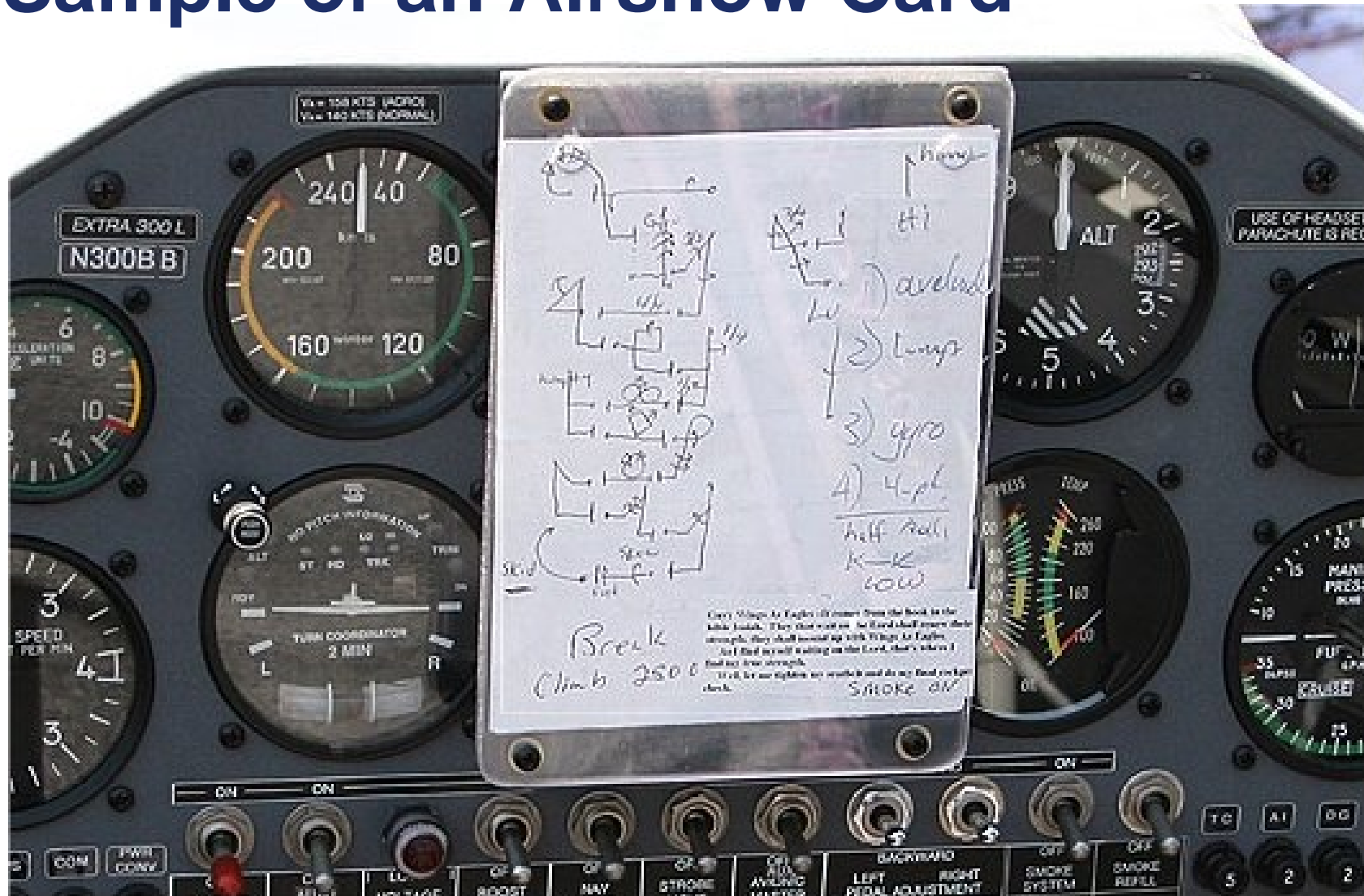
Danny Fritsche - Airplanespotters

NTSB Report

- On October 4, 2006, at 1325 mountain daylight time, an Extra Flugzeugbau GMBH EA 300/L, N300BB, owned operated by a commercial pilot, was substantially damaged when it impacted terrain at Tucumcari Municipal Airport (TCC), Tucumcari, New Mexico.
- The **pilot** sustained **fatal injuries**



Sample of an Airshow Card

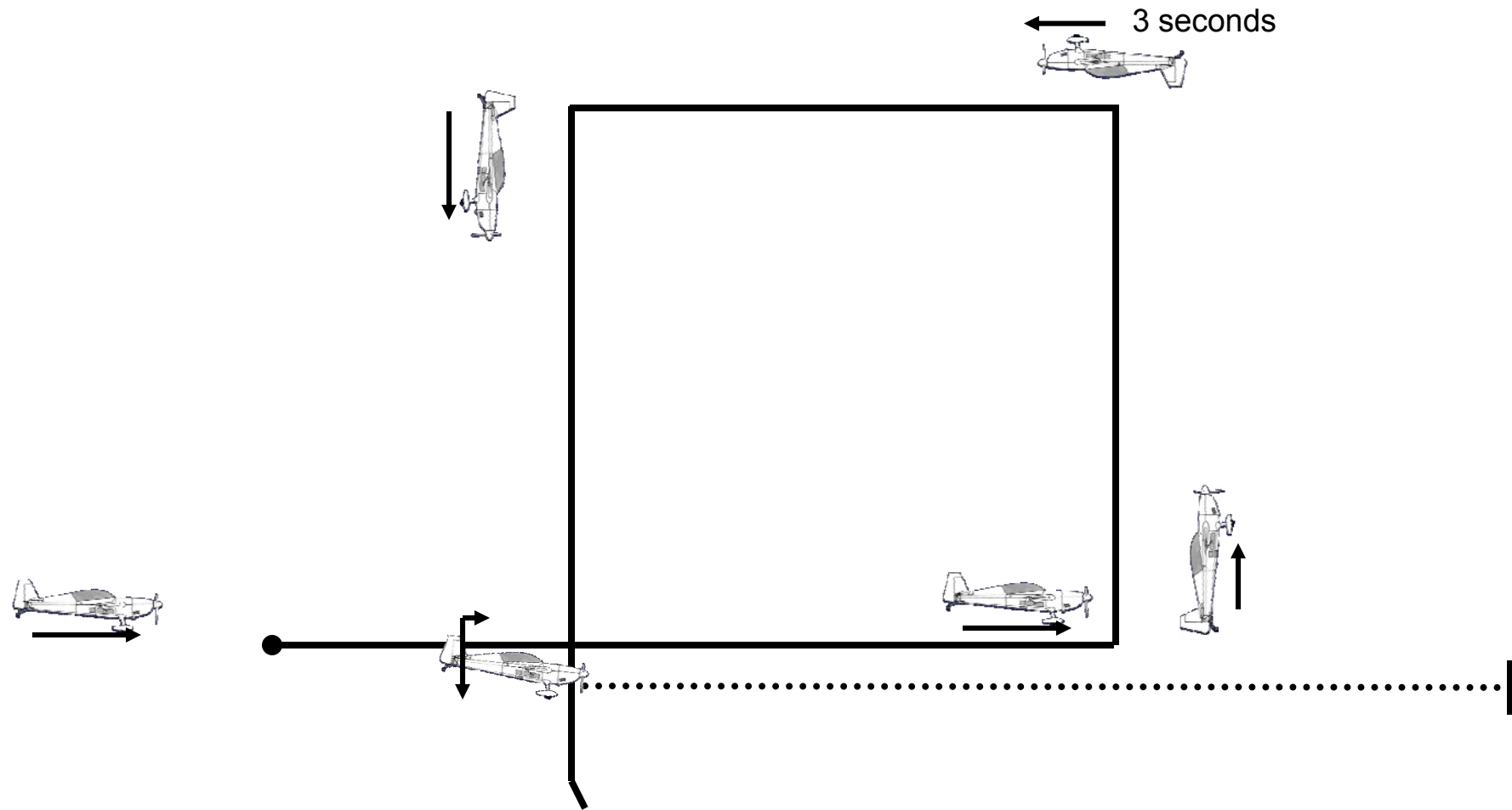


Meteorological Conditions

- **Airfield Altitude 4065 ft msl**
- **Winds 060° at 15 kts G 20 kts**
- **Density altitude 5700 ft**



Accident Maneuver (square loop – down wind)













Photograph 05 - Main wreckage - Right side view

Aeromedical Discussion

- **Metoprolol**
 - NTSB report - Identified on autopsy
- **Discussion on Beta blockers**



NTSB Probable Cause (5/29/2007)

- **The pilot's failure to maintain aircraft control during aerobatic flight, resulting in an inadvertent accelerated stall**
- **Contributing factors include the low altitude for recovery from the loop and the high density altitude**



Discussion
Questions ?

