

Medical Review of Aircraft Accidents

PROCESS and EXAMPLES



September 17, 1908, Fort Myer, Virginia





Lt. Selfridge being tended to.

Head trauma is evident.



ACGME Program Requirement

- Graduate Medical Education in Aerospace Medicine:
- “...providing appropriate safety information and education and conducting the medical aspects of any mishap investigation, including making recommendations to prevent recurrences...”



Aerospace Accident Investigation

- Accident investigation currently is a joint effort between FAA and NTSB.
 - When a criminal act is suspected, the FBI may act as the lead agency. The crash site is treated as a crime scene.
- Each agency has different responsibilities and functions.
- Each agency provides an Investigator-In-Charge (IIC) and support staff as needed.



What Is An Aircraft Accident

- Aircraft accident means an occurrence associated with the operation of an aircraft which takes place between the time any person boards the aircraft **with the intention of flight** and all such persons have disembarked, and in which any person suffers death or serious injury, or in which the aircraft receives substantial damage. For purposes of this part, the definition of “aircraft accident” includes “unmanned aircraft accident,”
 - **Fatal** injury means any injury which results in death within 30 days of the accident.
 - **Serious injury** means any injury which: (1) Requires hospitalization for more than 48 hours, commencing within 7 days from the date of the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes, or nose); (3) causes severe hemorrhages, nerve, muscle, or tendon damage; (4) involves any internal organ; or (5) involves second- or third-degree burns, or any burns affecting more than 5 percent of the body surface.
 - **Substantial damage** means damage or failure which adversely affects the structural strength, performance, or flight characteristics of the aircraft, and which would normally require major repair or replacement of the affected component. Engine failure or damage limited to an engine if only one engine fails or is damaged, bent fairings or cowling, dented skin, small punctured holes in the skin or fabric, ground damage to rotor or propeller blades, and damage to landing gear, wheels, tires, flaps, engine accessories, brakes, or wingtips are not considered “substantial damage” for the purpose of this part.

49 CFR § 830.2 - Definitions





National Transportation Safety Board

- Independent investigative agency established in 1967.
 - Five Board Members nominated by the President and confirmed by the Senate to serve five-year terms.
 - Funded directly by Congress and responsible directly to Congress.
 - The Safety Board has no regulatory or enforcement powers.
- They are responsible for all civil transportation and pipeline accident investigation in the United States.
 - They determine **probable cause** of an accident.
- NTSB makes recommendations to the FAA.



Roles of the FAA

- Of the 9 FAA responsibilities - the Office of Aerospace Medicine (AAM) helps answer 3:
 1. Performance of FAA facilities or functions was a factor,
 2. Performance of non-FAA owned and operated air traffic control (ATC) facilities or navigational aids was a factor,
 3. Airworthiness of FAA-certificated aircraft was a factor,
 4. Competency of FAA-certificated airmen, air agencies, commercial operators, or air carriers were involved,
 5. **Federal Aviation Regulations were adequate,**
 6. Airport certification safety standards or operations were involved,
 7. Airport security standards or operations were involved,
 8. **Airman medical qualifications were involved,** and
 9. **There was a violation of Federal Aviation Regulations.**

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02/02/2010



The Process

- All accidents, inflight incidents, runway incursions, and air traffic oversights are reviewed every day
- All Fatal accidents are given a Medical Review
 - Initial Review when accident occurs
 - Final Review after obtain Autopsy and Toxicology
- Attempt to obtain Autopsy on all Fatal accidents
- CAMI performs Toxicology on ALL Fatal accidents (Contract with NTSB)

Process (cont'd)

- Obtain News articles on accident
- Picture of exemplar aircraft and accident aircraft when possible
- Look up the “N” number of the accident aircraft
- Obtain the Pilot’s Airman Certification status
- Review the entire FAA aeromedical certification file on the pilot
- Make observations and recommendations to investigators
- Add Toxicology and Autopsy reports when available
- Draw final conclusions and recommendations after above

Airmen Inquiry

Search Page

Search Options



You can now search airmen by last name, last name and certificate number, or last name and other advance criteria such as first name, date of birth or city.

* Required

* Last Name: Certificate Number: (* Requires last name)

First Name: (may be partial or include middle name)

Date of Birth: Day: Year: (e.g. 1974)

City:

State:

- OR - Country:

Search

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Aircraft Certification

Registration Inquiry



The Aircraft Registration Inquiry database provides aircraft registration information through fourteen different queries:

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-
- Name Inquiry
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These queries provide information about current registered owners, documents filed, aircraft dealers, and more. We've included a definitions page to help visitors who may be unfamiliar with some of the aircraft registration terminology.

This site is updated each federal workday at midnight U.S. Central Standard Time.

[Search Aircraft Registration Inquiry database](#)

Page last modified: December 06, 2019 2:46:42 PM EST



Home

Aviation Accident Database & Synopses

The NTSB aviation accident database contains information from 1962 and later about civil aviation *accidents* and selected *incidents* within the United States, its territories and possessions, and in international waters. Generally, a **preliminary** report is available online within a few days of an accident. **Factual** information is added when available, and when the investigation is completed, the preliminary report is replaced with a **final** description of the accident and its probable cause. Full narrative descriptions may not be available for dates before 1993, cases under revision, or where NTSB did not have primary investigative responsibility.

- [Monthly lists](#) - accidents sorted by date, updated daily.
- [Investigations Nearing Completion](#) - List of investigations with estimated dates of publishing probable cause.
- [Downloadable datasets](#) - one complete dataset for each year beginning from 1982, updated monthly in Microsoft Access 2000 MDB format; this site also provides weekly "change" updates and complete documentation.
- [GILS record](#) - complete description of the accident database, including definition of "accident" and "incident".
- [FAA incident database](#) - complete information about incidents, including those not investigated by NTSB, is provided by the Federal Aviation Administration.
- [Data & Information Products](#) - lists other sources of information about aviation accidents, including publications, dockets, and press releases

This is the interactive search capability for the NTSB database, updated daily; see the [data dictionary](#) before using the form for the first time.

Search the Aviation Accident Database

 Download All (XML)  Download All (Text)  Help

Accident/Incident Information

Event Start Date (mm/dd/yyyy)

Event End Date (mm/dd/yyyy)

Month

All ▼

City

Objectives of the Autopsy - 1

- Who died?
- What was the cause of death?
- What was the manner of death?
 - Homicide, suicide, accident, natural, undetermined.
- What were the nature and sequence of traumatic events?
 - If someone initially survived, why did they eventually die?
 - What was the post-crash environment?
 - Injury types: intrusive/contact, impact/decelerative, or thermal.

Objectives of the Autopsy - 2

- What interactions between victim and aircraft structures/components resulted in the fatal injuries?
 - Identifies survival factor problems.
 - Injury patterns may show failure of safety systems – restraints, seats, fuel systems, etc.
 - Witness marks - can a connection be made from specific parts in the aircraft to the body?
- What were the decelerative forces?

Objectives of the Autopsy - 3

- Would any modifications to the aircraft or its equipment have improved survival?
- What role, if any, did the victims play in causing the crash?
 - Is it possible to tell who was flying?
 - Was the pilot incapacitated?
 - Were there medical, physiologic or toxicologic factors present?*
 - Did the other occupant(s) play a role?

Human Tolerances

Pulmonary contusion	25G
Nasal fracture	30G
Vertebral body – compression**	20-30G
Fracture dislocation of C1-C2**	20-40G
Mandible - fracture	40G
Maxilla - fracture	50G
Aorta - intimal tear	50G
Aorta - transection	80-100G
Pelvis - fracture	100-200G
Vertebral body - transection	200-300G
Total body fragmentation	>350G

Human Tolerance and Crash Survivability, Dennis F. Shanahan, M.D., M.P.H. - Injury Analysis, LLC

Direction of Accelerative Force	Occupant's Inertial Response	Tolerance Level
Headward (+Gz)	Eyeballs down	20-25G
Tailward (-Gz)	Eyeballs up	15G
Lateral right (+Gy)	Eyeballs left	20G
Lateral left (-Gy)	Eyeballs right	20G
Back to chest (+Gx)	Eyeballs out	45G
Chest to back (-Gx)	Eyeballs in	45G

Time duration of 0.10 seconds, full restraint

USN Aircraft Mishap Investigation Pocket Reference, 3rd edition

Survivability

- Human tolerances depends on five factors:
 - Magnitude of the acceleration - less is best.
 - Direction of the acceleration - vertical (Gz) is poorly tolerated.
 - Duration of the acceleration - short is best.
 - Rate of onset of the acceleration - small is best.
 - Occupant position, restraint and support - extremely important.
- If calculated crash forces on the airframe exceed the human tolerance limits by:
 - a factor of 2, survival is unlikely;
 - a factor of 1.5 survival is doubtful;
 - a factor of <1.5 survivability is likely dependent on specific CREEP factors.

CREEP Factors

- Container – was there airframe integrity with occupiable space?
- Restraints – were they worn and did they work?
- Environment – was aircraft design an issue?
- Energy absorption – was energy absorbed by the airframe, restraints and seats?
- Post-crash factors – fire, toxic fumes, egress points, etc.?



Review of Toxicology

- Toxicology is usually part of every autopsy.
- FAA Toxicology Boxes distributed throughout the country FSDOs.
 - Given to ME or coroner by FAA investigators.
 - 1 box per fatality.
- Toxicology samples sent to CAMI for analysis.



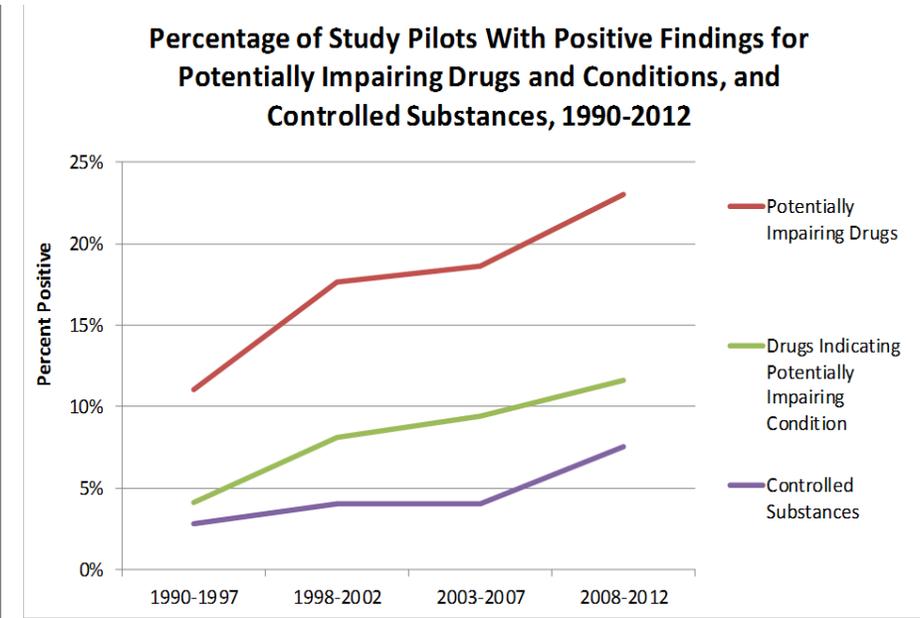
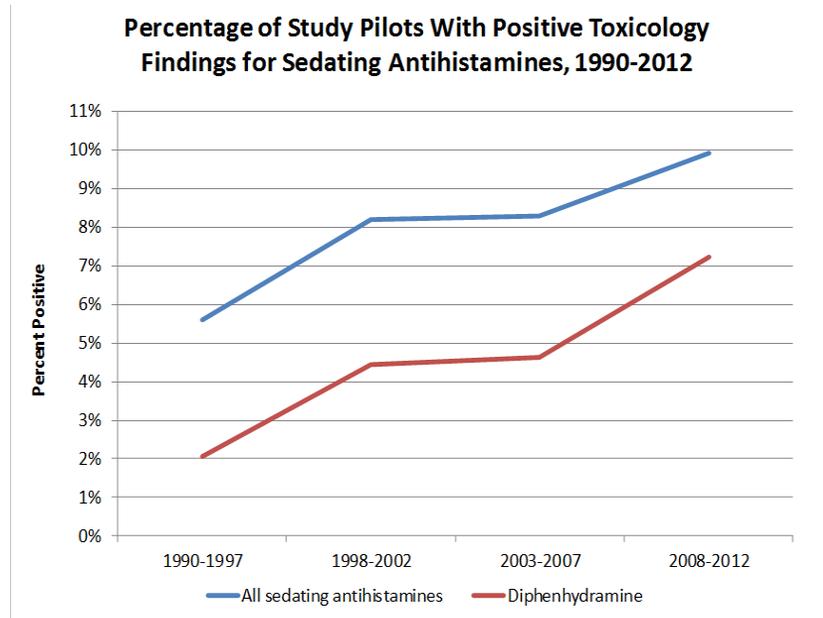
Were Medications or Drugs Involved?

- Were “tested-for” substances present?
- Was the airman taking reported or unreported medications, illicit drugs or alcohol?
 - FAA: Identify the substances.
 - NTSB: Were medications, illicit drugs, or alcohol a causal or contributory factors in the accident?
- Toxicology is crucial in determining this.

Medication Study Followup - 2015

- Prevalence of ethanol and drugs in deceased pilots has been evaluated by CAMI at 5-year intervals since 1989.
 - Latest version issued in 2015 was *Prevalence of Ethanol and Drugs in Civil Aviation Accident Pilot Fatalities, 2009 - 2013*.
 - Samples from 1,169 pilots were analyzed.
 - In relation to the first 5-yr period (1989–1993), the pilot fatality cases decreased by 37%, but the presence of ethanol and/or drugs in the pilots increased by 239%.
 - Ethanol usage was unchanged, but increases were noted in illicit and prescription drug usage.
- No studies on civil pilots who survive accidents.

NTSB Study 2014 – Troubling Trends



NTSB has cited pilot impairment due to drugs as a cause or contributing factor in 3.0% and impairment or incapacitation from a medical condition in 1.8% of fatal US civil aviation accidents - ethanol use was a probable cause or contributing factor in less than 2%.

Accident One





Medical Certification History

- 25-year-old male
- No prior civil flight experience
- Third-class medical certificate
- Negative medical history
- 0 Total Flight Hours and 0 past 6 months

Accident Event

- Accident day at 0119 PDT
- Cessna 150A -> departed RWY 8, turned Lt and flew West. At 0117, ~ 1.5 NM NW of RWY 8, plane turned Lt at 225deg. & crossed RWY on NE heading. At 0118, plane turned Rt. At 0119.31 plane turned Rt and was Southbound -> the plane impacted desert shrub trees along embankment of a river. Pilot and passenger Fatally injured.

<u>Analyte</u>	<u>Result</u>	<u>Specimen</u>	<u>Instrument</u>
Carboxyhemoglobin	Not Detected	Blood	UV/VIS
Ethanol	219 (mg/dL, mg/hg)	Blood	HSGC/FID
Ethanol	259 (mg/dL, mg/hg)	Vitreous	HSGC/FID
Ethanol	320 (mg/dL, mg/hg)	Urine	HSGC/FID
Glucose	32 (mg/dL)	Vitreous	Analyzer
Glucose	14 (mg/dL)	Urine	Analyzer
Cocaine	Detected	Blood	GC/MS
Cocaine	505 (ng/mL, ng/g)	Urine	GC/MS
Benzoylcegonine	29 (ng/mL, ng/g)	Blood	GC/MS
Benzoylcegonine	179 (ng/mL, ng/g)	Urine	GC/MS
Cocaethylene	Negative	Blood	GC/MS
Cocaethylene	74 (ng/mL, ng/g)	Urine	GC/MS

Ecgonine Methyl Ester		Detected	Blood	GC/MS
Ecgonine Methyl Ester		Detected	Urine	GC/MS

Accident Two



Medical History

- Pilot 66 years-old male
- Third-class medical certificate
- Accident occurred 7/20/2019
- Date of Exam 9/02/2009
- Denied third-class medical certification 12/03/2009
- Diabetes mellitus and HgA1C level 11.7%
- No Basic Med

Medical History (cont'd)

- Noted HTN, Diabetes mellitus, and h/o driving without proper insurance conviction
- “Had pig pancreas transplant in Mexico”
- AME deferred
- AMCD Denied and no new requests for FU
- 0 flight hours Total and 0 in past six months

Accident Scenario

- Pilot sole occupant
- No Flight Plan
- Witness noted plane began fast taxi, and lost sight due to trees N end of RWY. Heard plane's engine accelerate, then slow, then increase again, followed by sound of impact. Witness got into their vehicle and drove S, observed plane nose down, halfway down RWY, 100ft. E of centerline in restricted area
- Pilot fatally injured



Accident Two (cont'd)

- Autopsy findings:
 - Cardiomegaly with concentric LVH and fibrosis
 - Moderate to severe coronary arterial atherosclerosis
 - Calcified Aortic Valve
 - Medical records document elevated Troponin levels
 - Cirrhosis of Liver with Micronodular hepatic parenchyma
- Toxicology – insufficient antemortem specimen for Drugs

Accident Three



Medical History

- 56-year-old male
- 21,000 Total flight hours and 350 last 6 months
- Second-class medical certificate
- Diet-controlled diabetes mellitus since 1999

Accident Scenario

- Spraying “Headline AMP”, a fungicide
 - Health effects: Primary routes of entry Eye & Skin contact, ingestion and inhalation. Routes for gases include Inhalation & Skin contact.
 - May cause moderate but temporary eye irritation and slight skin irritation
- At 0721 CDT pilot overflowed destination airport at 200ft.agl and continued N-NW. Engine seemed to be running normally. Witness plane very low and “amazed it cleared trees”
- Plane struck set of power lines about 40ft. Agl. Then struck set of power lines, a roof mounted antenna, and power line support pole before crossing a paved, 2-lane road and impacting tree.
- Post impact fire

Accident Aircraft



Pilot Three Autopsy

- No soot/smoke inhalation
- Carbon monoxide level (on autopsy specimen) 5.2%
- Symmetric Cardiomegaly
- Myocardial fibrosis, anteroseptal consistent with remote infarction
- Microscopy consistent with acute myocardial ischemia
- Stents RCA and LAD
- Chronic (days) SAH, of uncertain significance
- Emphysematous changes Lungs

CAMI Toxicology

Analyte	Result	Specimen	Instrument
Carboxyhemoglobin	11 (%)	Blood (Femoral)	UV/VIS
Cyanide	Not Detected	Blood (Heart)	COLOR
Ethanol	Not Detected	Blood (Femoral)	HSGC/FID
Glucose	Not Detected	Vitreous	Analyzer
Glucose	Not Detected	Urine	Analyzer
Hydrocodone	190 (ng/mL, ng/g)	Blood (Heart)	GC/MS
Hydrocodone	145 (ng/mL, ng/g)	Liver	GC/MS
Dihydrocodeine	41 (ng/mL, ng/g)	Blood (Heart)	GC/MS
Dihydrocodeine	84 (ng/mL, ng/g)	Liver	GC/MS
Fentanyl	20.1 (ng/mL, ng/g)	Blood (Heart)	LC/MS
Fentanyl	44.2 (ng/mL, ng/g)	Liver	LC/MS
Norfentanyl	94 (ng/mL, ng/g)	Blood (Heart)	LC/MS
Norfentanyl	192.6 (ng/mL, ng/g)	Liver	LC/MS
Trazodone	901 (ng/mL, ng/g)	Blood (Heart)	GC/MS
Trazodone	2,500 (ng/mL, ng/g)	Liver	GC/MS

Toxicology Autopsy Specimens

- Toxicology-Femoral blood
 - A. Lorazepam: 5.5 ng/mL.
 - B. Dihydrocodeine/Hydrocodol - Free 17 ng/mL.
 - C. Hydrocodone - Free: 55 ng/mL.
 - D. Yohimbine: 110 ng/mL.
 - E. Trazodone: 0.42 mcg/mL.
 - F. Fentanyl: 9.5 ng/mL
 - G. Norfentanyl: 32 ng/mL
 - H. 4-ANPP (weak fentanyl metabolite), Caffeine, Cotinine, Nicotine: positive.

Accident Four



Medical History

- 74-year-old male Physician
- Warbird pilot
- 7,173 flight hours and 66 past 6 months
- Second-class medical certificate
- H/O Basilar artery embolus from AFIB 10 years ago, Successful pulmonary vein ablation AFIB -> total recovery and issued 1-year later
- Benign prostatic hypertrophy
- Rt hip replacement
- Cataract surgery

Accident Scenario

- Cessna 414A destroyed when impacted trees and houses
- Plane 2.25 NM from GPS-A missed approach point at 400 ft. altitude and 90 knot ground speed. Course constant for 17 sec., then ground speed slowed to 80 knots, 12 sec later course constant and slowed to 70 knots, 11 sec later descended to 375ft., turned Lt to 050deg. And ground speed 66 knots. Then 175ft. msl, headed 321deg, 82 knots
- Two doorbell cameras noted shallow Lt bank and entered rapid descending left turn near treetops, continued to roll left and then impact.

Accident Aircraft



Toxicology

<u>Analyte</u>	<u>Result</u>	<u>Specimen</u>	<u>Instrument</u>
Carboxyhemoglobin	34 (%)	Blood (Cardiac)	UV/VIS
Cyanide	Not Detected	Blood (Cardiac)	COLOR
Ethanol	Not Detected	Blood (Cardiac)	HSGC/FID
Glucose	50 (mg/dL)	Vitreous	Analyzer
Glucose	16 (mg/dL)	Urine	Analyzer
Irbesartan	Detected	Blood (Cardiac)	LC/MS
Irbesartan	Detected	Urine	LC/MS
Famotidine	Detected	Blood (Cardiac)	LC/MS
Famotidine	Detected	Urine	LC/MS
Tamsulosin	Detected	Blood (Cardiac)	LC/MS
Tamsulosin	Detected	Urine	LC/MS

Autopsy Accident Four

- Cause of Death: Blunt impact of Head

Smoke inhalation

Soot in trachea and main bronchi

Accident Five



Medical History

- 59-year-old male
- 8,000 Total Flight hours and 225 last 6 months
- Second-class medical certificate
- Reported no medical conditions
- Negative PMH on all previous flight exams

Accident Scenario

- About 1310 EDT OV-1D
- Only reason to fly that day to visually locate Acrobatic box to be ready for show
- Appeared to crew chief who was observing on last pass when turn from base leg of traffic pattern onto final leg, appeared bank angle exceeded 90deg. Plane did a rapid Rt roll to inverted position, and nose dropped to what appeared to be 45deg. Nose down followed by impact and fireball.

Accident Aircraft



Toxicology

Analyte	Result	Specimen	Instrument
Ethanol	626 (mg/dL, mg/hg)	Liver	HSGC/FID
Ethanol	47 (mg/dL, mg/hg)	Muscle	HSGC/FID
Ethanol	Not Detected	Lung	HSGC/FID
Ethanol	10 (mg/dL, mg/hg)	Kidney	HSGC/FID
Ethanol	Not Detected	Brain	HSGC/FID
Acetone	Detected	Liver	HSGC/FID
Propanol (N-)	Detected	Liver	HSGC/FID
Propanol (N-)	Detected	Muscle	HSGC/FID
Isopropanol	Detected	Lung	HSGC/FID
Citalopram	Detected	Liver	GC/MS
Citalopram	Detected	Muscle	GC/MS
N-Desmethylcitalopram	Detected	Liver	GC/MS
N-Desmethylcitalopram	Detected	Muscle	GC/MS
Rosuvastatin	Detected	Liver	LC/MS
Rosuvastatin	Detected	Muscle	LC/MS

Top Ten Medications Found on Toxicology (as of 2017)

- Diphenhydramine
- Cannabinoids
- Acetaminophen
- Ibuprofen
- Atorvastatin
- Metoprolol
- Amphetamine
- Hydromorphone
- Losartan
- Naproxen