Aerospace Medical Research

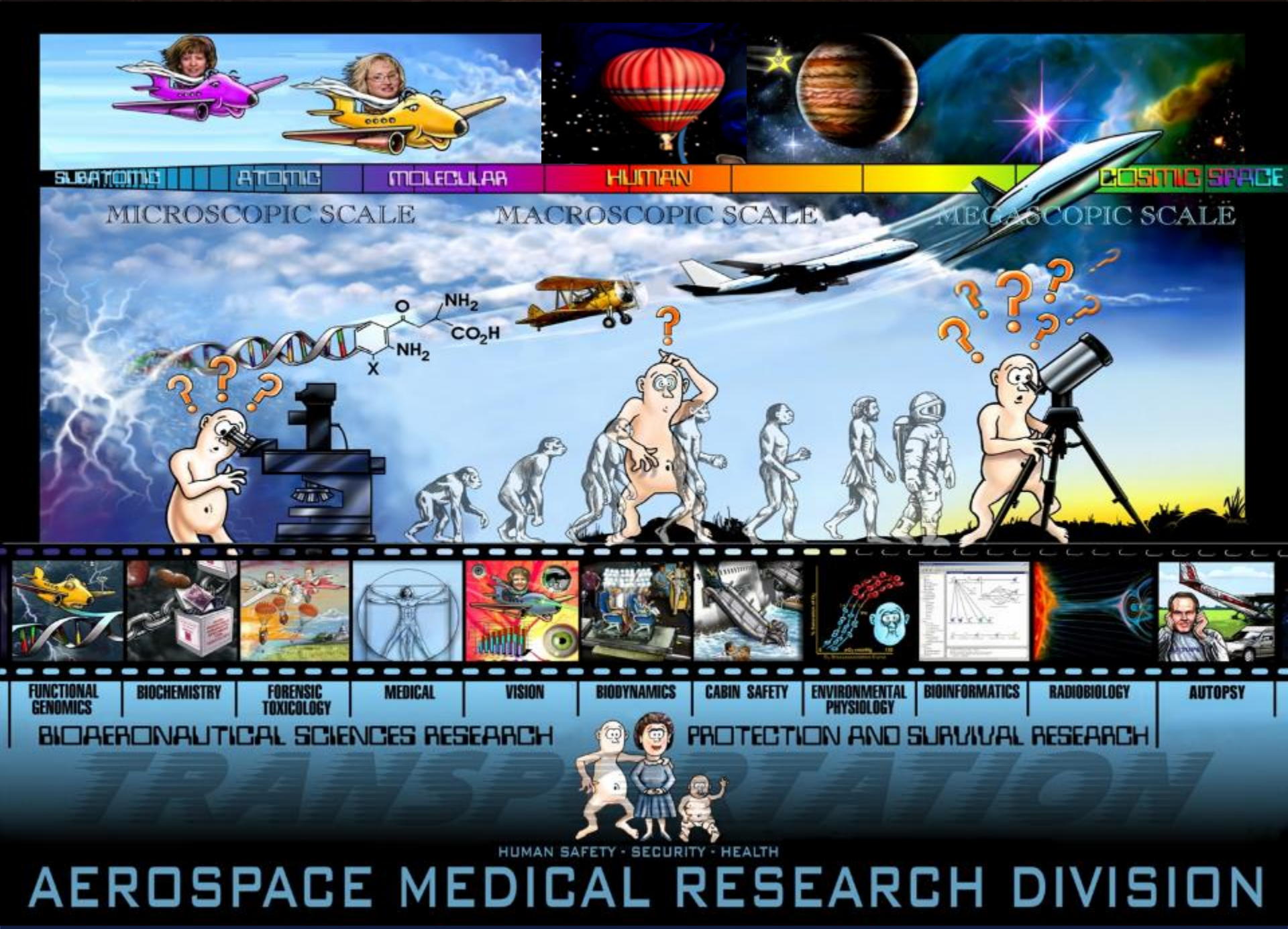
CIVIL AEROSPACE MEDICAL INSTITUTE

Estrella M. Forster, Ph.D., FAsMA, FNAVAIR, PMP

CAMI AAM-600, Oklahoma City, OK

March, 2017

Civil Aerospace Medical Institute


SUBATOMIC
ATOMIC
MOLECULAR
HUMAN
COSMIC SPACE
MICROSCOPIC SCALE
MACROSCOPIC SCALE
MEGASCOPIC SCALE
FUNCTIONAL GENOMICS
BIOCHEMISTRY
FORENSIC TOXICOLOGY
MEDICAL
VISION
BIODYNAMICS
CABIN SAFETY
ENVIRONMENTAL PHYSIOLOGY
BIOINFORMATICS
RADIOBIOLOGY
AUTOPSY
BIOAERONAUTICAL SCIENCES RESEARCH
PROTECTION AND SURVIVAL RESEARCH
HUMAN SAFETY · SECURITY · HEALTH
AEROSPACE MEDICAL RESEARCH DIVISION

Mission

Develop new and innovative ways to <u>support FAA regulatory and advisory missions</u> to improve the safety of humans in civilian aerospace operations.

Approach

Proactive

be prepared

Pre-eminent

be the best

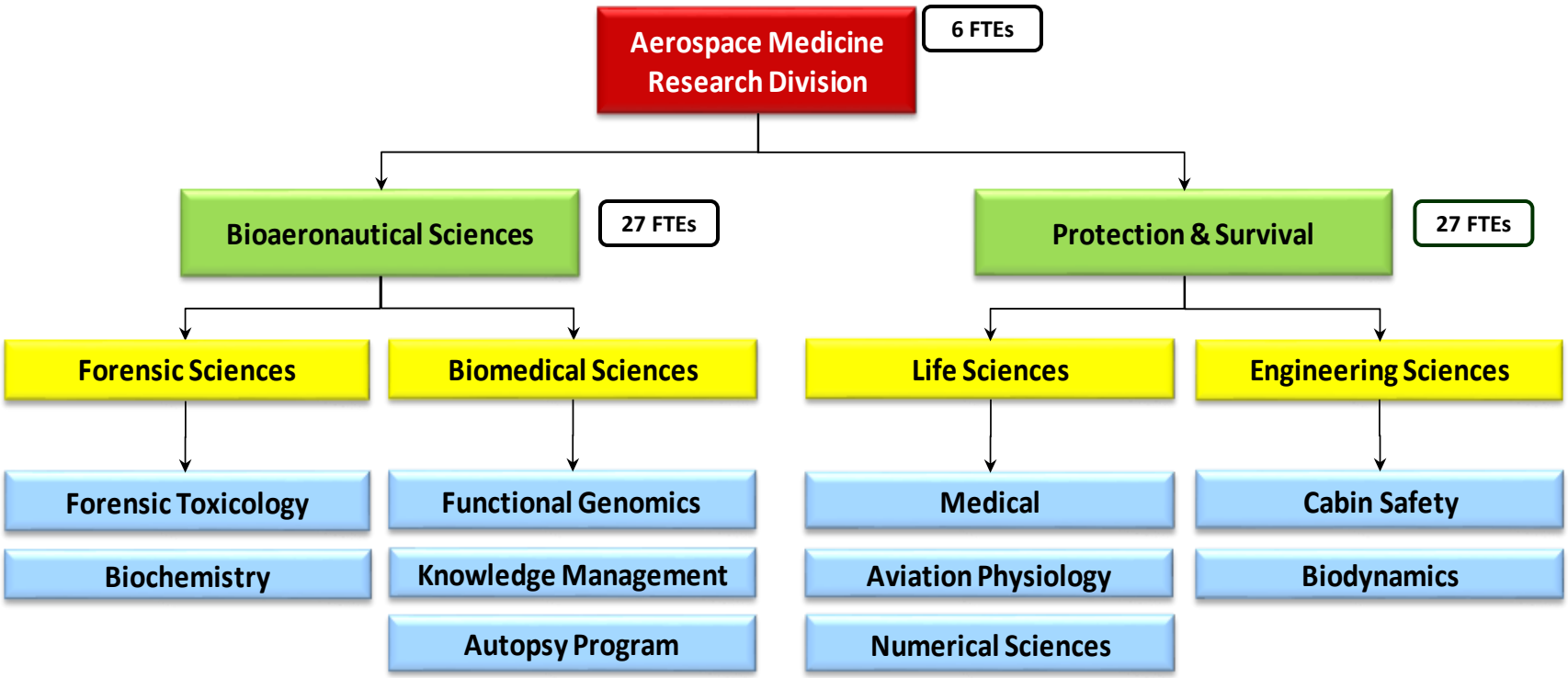
Collaborative

share

Contribution

1. ***Continued Operational Safety –*** **Results of research maximize the strengths of the human link in the NAS and minimize inherent human weakness to prevent accidents and improve safety through *evidence-based medicine*.**
2. ***Standards and Policy –*** **Investigation and analysis of injury and death patterns in civilian flight accidents and incidents results in the development of preventive strategies including language for proposed standards, regulations, educational materials, and policies.**
3. ***Risk Management –*** **Support accident investigation and medical certification processes to identify hazards and augment safety information systems towards an *Aeromedical Safety Management System*.**
4. ***Certification –*** **Provides criteria concerning equipment, technology, and procedures for human protection and survival from stressful environments/emergency events.**

Organization



60 In-House FTEs:

- *GOV: 50 R&D and 2 OPS*
- *CTR: 7 R&D and 1 OPS*

1 Division
2 Branches
4 Sections
10 Teams

Resources: Knowledge & Experience

Scientists, physicians, engineers, technical, and administrative staff

1,388 years of knowledge, skills, and experience
Median = 25 yrs.

Resources: Education & Skills

12	Associate
41	Baccalaureate
31	Master
17	Doctorate (13 PhD, 4 MD/DO)
13	Additional registrations, licenses, and certificates
7	Pilots
149	Professional Organizations – Liaison/Membership
10	Fellows of various professional organizations
75	Professional Committees or Workgroups Membership

Resources: Facilities & Equipment

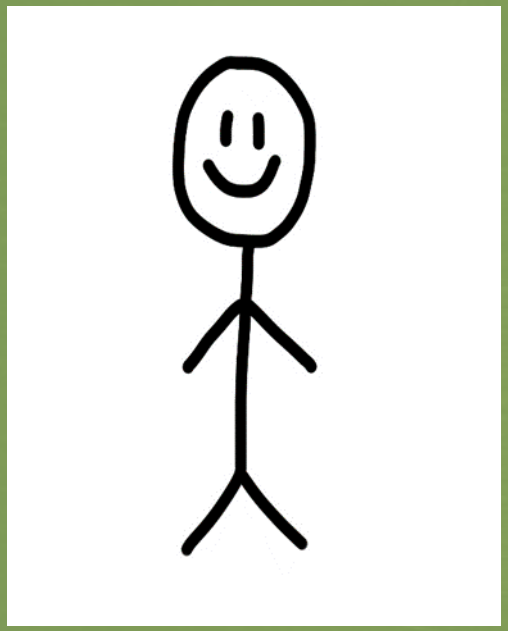
- B-747 Aircraft Environment Research Simulator (AERF)
- FlexSim Aircraft Cabin Research Simulator (ACRF)
- Water Survival Research Tank (WSRT)
- B-727 Aircraft In-Flight Firefighting Research Laboratory
- Cabin Safety Research Laboratories
- SLED – Horizontal Accelerator – Impact Test Bed
- Anthropometric Test Device (ATD) Shop
- Machine/Fabrication Shop
- Altitude (Hypobaric) Research Chamber
- Physiology Research Laboratory
- High Performance Computer
- Wet & Dry Laboratories
  - State of the Art Biological Processing Equipment
  - State of the Art Analytical Instrumentation
- 100s of Biochemistry/Physiology/Engineering Equipment and Analytical Software

AMEN I $18 M Investment FY12 – FY14

AMEN II $8.6 M Investment FY16 – FY20

WiWaves $50 M Investment FY18 – FY21 (AMS)

AMS= Undergoing FAA Acquisition Management System approval process

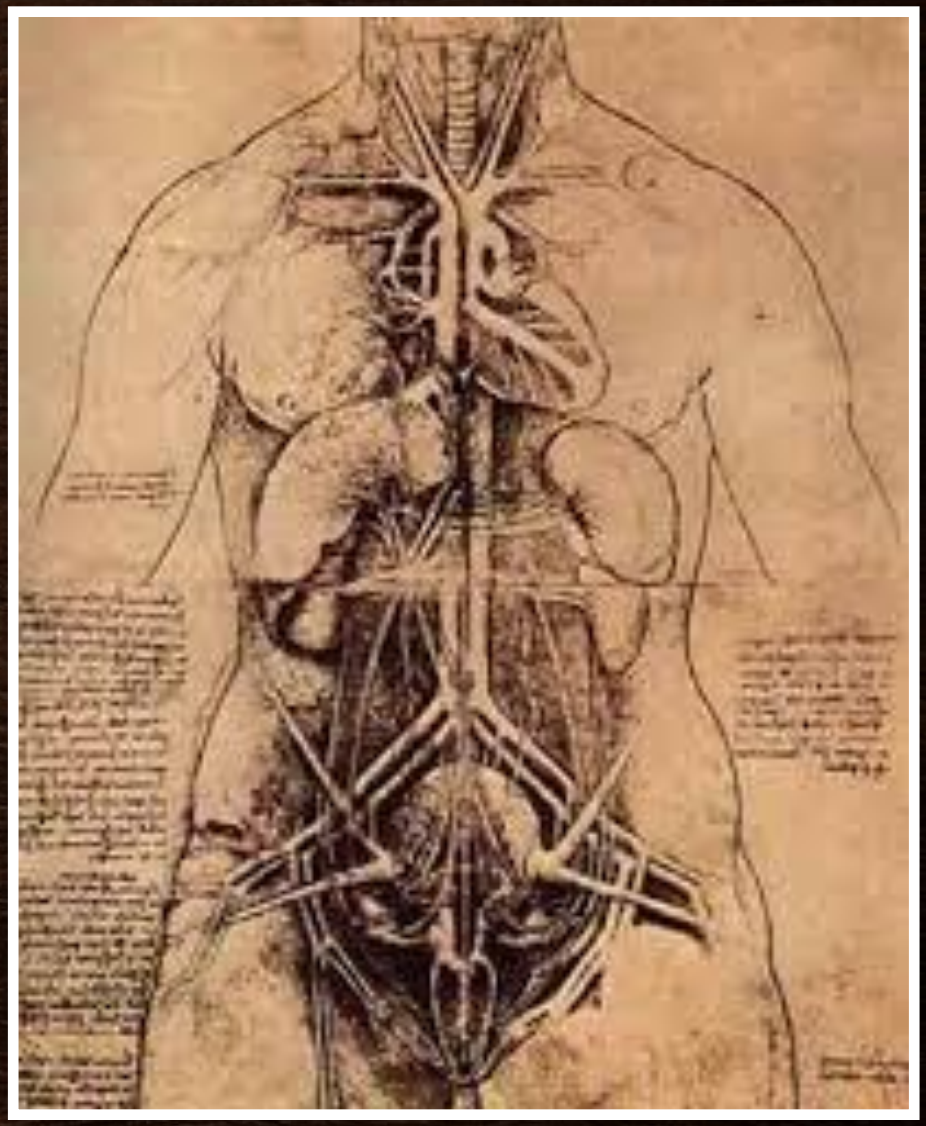


Vacancy
Dr. Philip Kemp
Acting

BIOAERONAUTICAL SCIENCES RESEARCH

AAM-610

N= 27 FTEs



FORENSIC SCIENCES SECTION

Dr. Philip Kemp

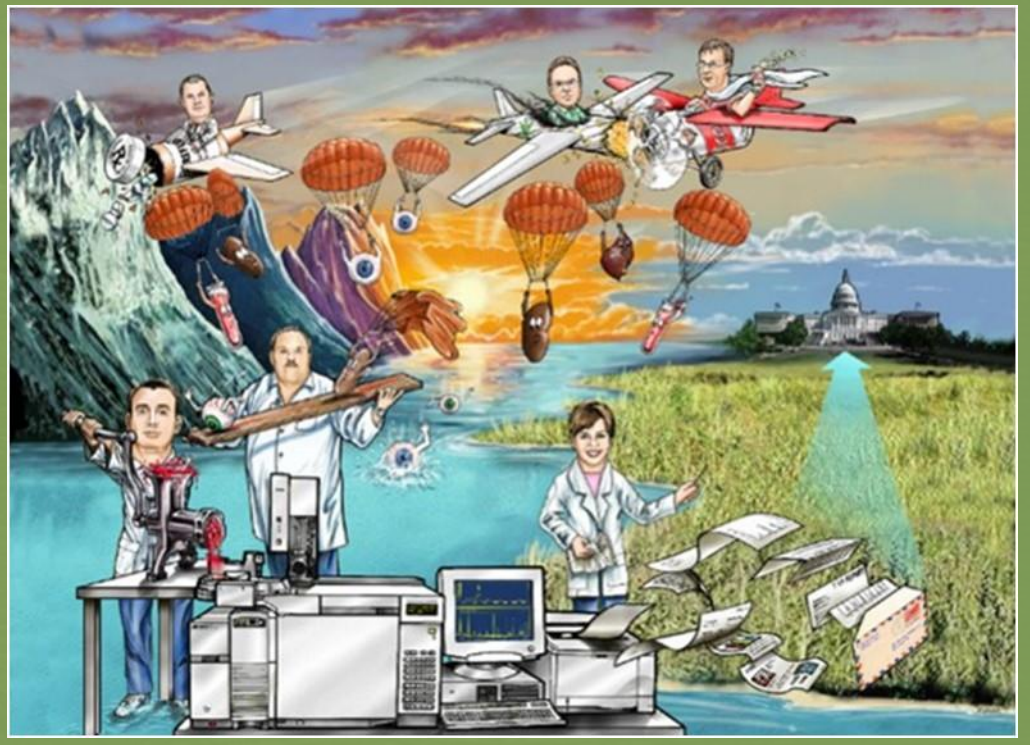
AAM-611

2 Research Teams

FORENSIC TOXICOLOGY RESEARCH TEAM

Dr. Russell Lewis

Team Lead



Analyses of Biologicals

Whole Blood Specimens
Vitreous Humor
Spinal Fluid
Urine
Gastric Contents
Bile
Liver
Kidney
Heart
Lung
Spleen
Brain
Muscle

Examine Accident Victims for the presence of…

ALCOHOL | **ILLEGAL SUBSTANCES** | **MEDICATIONS** | **TOXINS**

- Cause of accident
- Contributory to accident
- Indicative of medical condition
- Absence of required drug
- Survival after the accident

Research: Prevalence of ...

DRUG ABATEMENT

Forensic Toxicology Reports

CAMI CASE # NAME PUTREFACTION: No

DATE OF ACCIDENT DATE RECEIVED

LOCATION OF ACCIDENT

SPECIMENS Blood, Brain, Gastric, Heart, Kidney, Liver, Lung, Muscle, Spleen, Urine, Vitreous

FINAL FORENSIC TOXICOLOGY FATAL ACCIDENT REPORT

CARBON MONOXIDE: The carboxyhemoglobin saturation was determined by spectrophotometry with a 10% cut off.

>> NO CARBON MONOXIDE detected in Blood

CYANIDE: The presence of cyanide was screened by Conway Diffusion. Positive cyanides are quantitated using spectrophotometry. The limit of quantitation of cyanide is 0.25 ug/mL. Normal blood cyanide concentrations are less than 0.15 ug/mL, while lethal concentrations are greater than 3ug/mL.

>> NO CYANIDE detected in Blood

VOLATILES: The volatile concentrations were determined by headspace gas chromatography at a cut off of 10 mg/dL. All positive ethanols were confirmed by Radiative Energy Attenuation.

>> NO ETHANOL detected in Urine

DRUGS: Immunoassay and chromatography are used to screen for legal and illegal drugs which include: amphetamine (0.010), opiates (0.010), marihuana (0.001), cocaine (0.020), phencylidine (0.002), benzodiazepines (0.030), barbiturates (0.060), antidepressants (0.100), antihistamines (0.020), meprobamate (0.100), methaqualone (0.100), and nicotine (0.050). The values in () are the threshold values in ug/mL used to report positive results. Values below this concentration are normally reported as not detected. GC/Mass Spec, HPLC/Mass Spec, or GC/FTIR, is used to confirm most positive results.

>> 0.038 (ug/ml, ug/g) TEMAZEPAM detected in Blood
>> 0.042 (ug/ml, ug/g) TEMAZEPAM detected in Urine
>> OXAZEPAM detected in Urine

Expert Witness Services

ACCIDENT CAUSATION

COURT TESTIMONY

BIOCEMISTRY RESEARCH TEAM

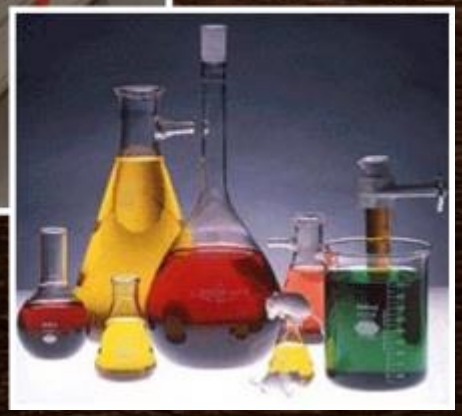
Kacey Cliburn

Team Lead

Evidence

Accident

Sample Collection "TOX BOX"



Analysis

CHAIN OF CUSTODY

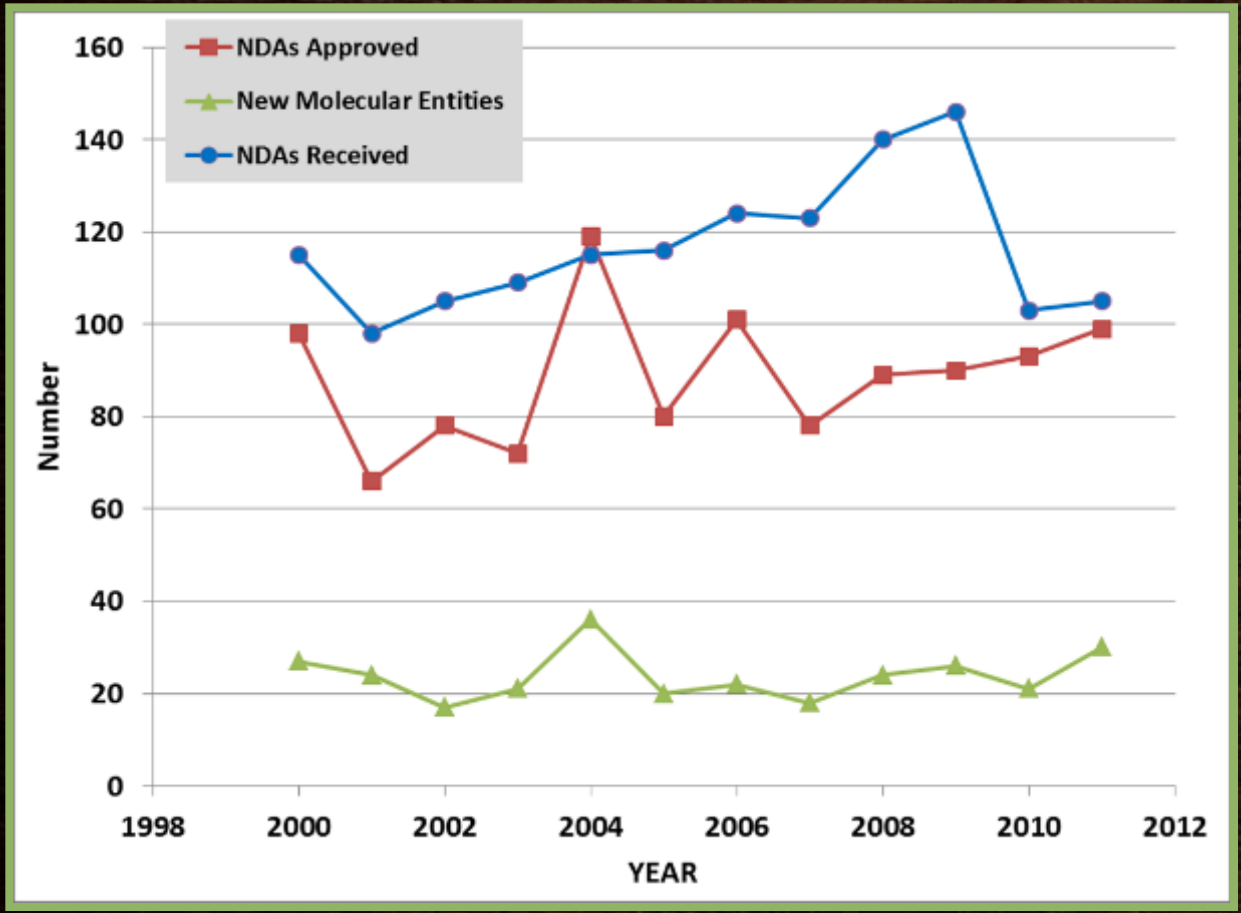
LAB PROCEDURES

QUALITY

Development of Lab Procedures

"All substances are poisons; there is none which is not a poison; The right dose differentiates a poison from a remedy."
Paracelsus (1493-1541)

http://www.fda.gov NDA = New Drug Application



Quality Assurance/Quality Control

College of American Pathologists

American Board of Forensic Toxicology

BIOMEDICAL SCIENCES SECTION

Dr. Hilary Uyhelji

AAM-612

3 Research Teams

FUNCTIONAL GENOMICS RESEARCH TEAM

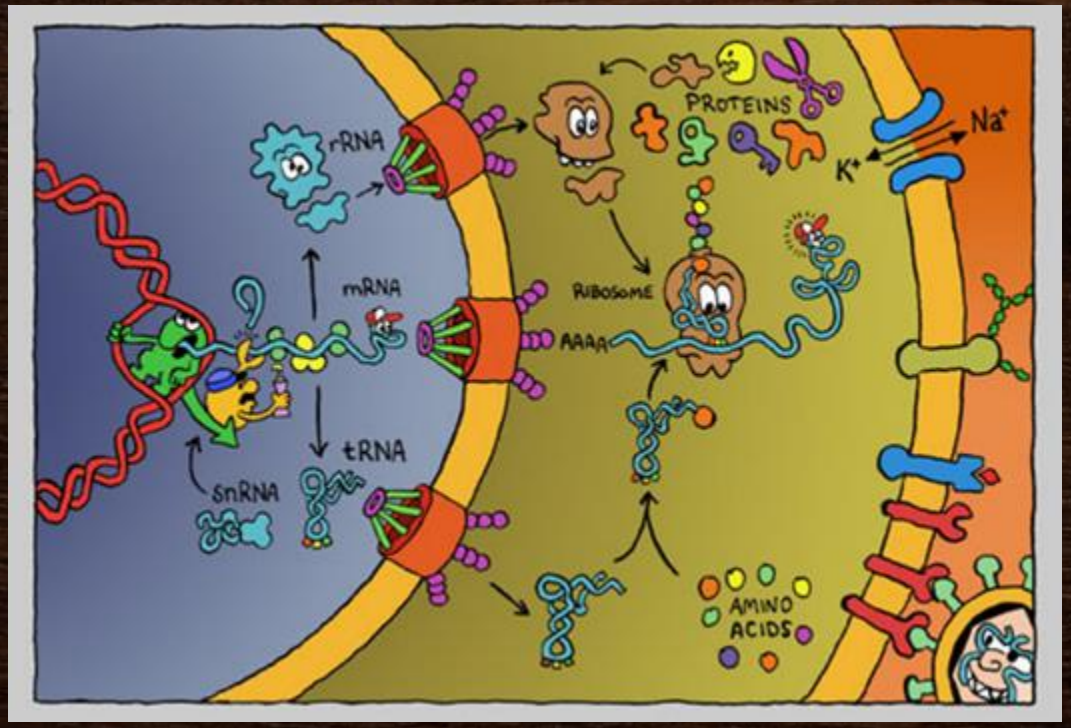
Dr. Dennis Burian

Team Lead

Gene Expression

Gene expression is the process of using the information encoded in the DNA to manufacture a protein from its amino acid components

stress



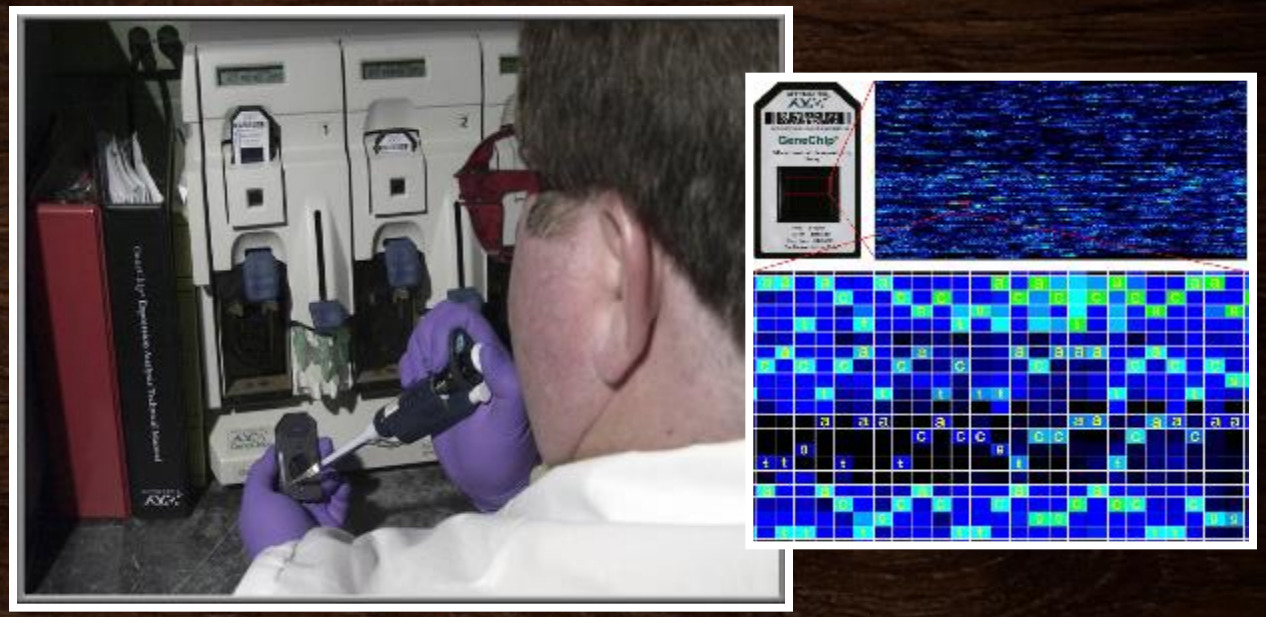
response

http://old.mb.au.dk/dogma.html, Dept. of Molecular Biology, University of Aarhus, Denmark

Gene Expression Research

FACTORS

DRUGS
STRESSORS
FATIGUE
HYPOXIA
ALCOHOL
PATHOLOGY



GENE EXPRESSION

PERFORMANCE COMPROMISE

HEALTH RISKS

The use of micro arrays or "DNA chips" allows the functional understanding of the human genome and how gene expression changes in response to the aviation and space environments

SAFETY

HAZARDS

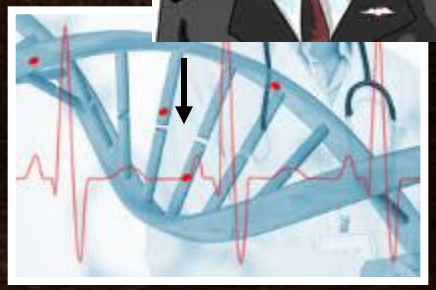
RISK

Towards a Genomics "Black Box"

Black Box

Other Factors

Human Factors



Monitors flight data and the Cockpit Voice Recorder (CVR) records conversation and other audible cockpit noises

Interpretation

Aeromedical Hazards

Monitors 40,000 genes associated with stimuli experienced by the human body

Christy Hileman

Team Lead

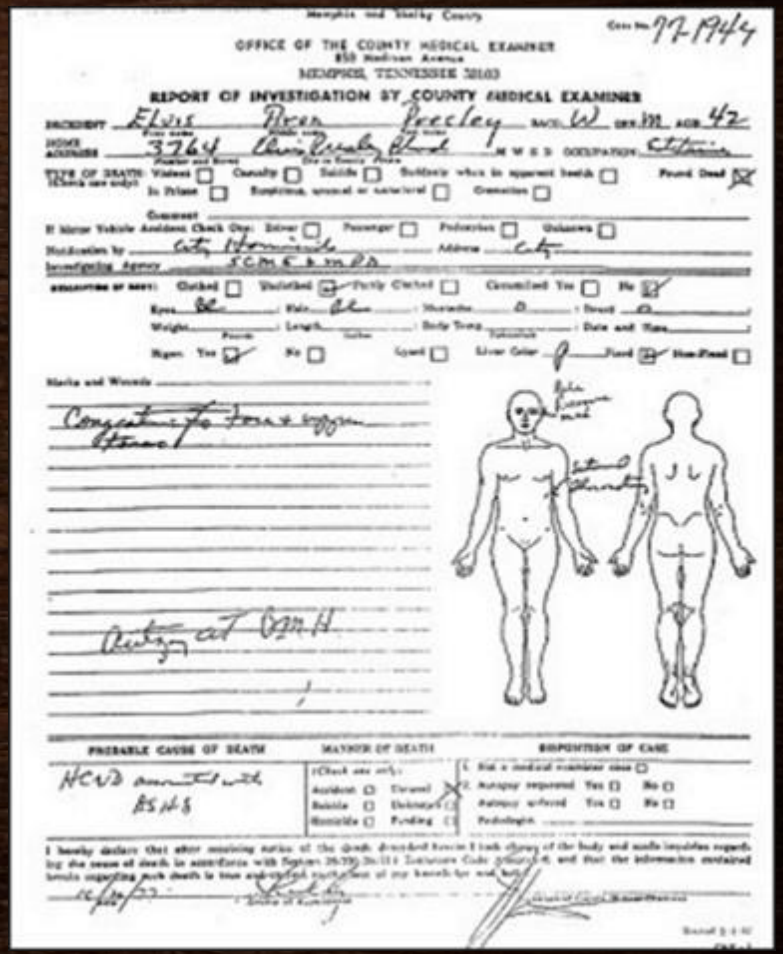
Operational Team

AUTOPSY PROGRAM TEAM

DATA MANAGEMENT AVIATION SAFETY

National Autopsy Program

Coordination, Acquisition, Storage, Maintenance, and Mining of autopsy records and related aircraft accident information



Accident information:

- **Coroners/Medical Examiners**
- **Law Enforcement Personnel**
- **Others pertinent to accident investigation**

Supports:

- Research
- Aeromedical Accident Review

Dr. Guillermo Salazar

Accident site

PILOT INFORMATION: (FATAL)

Pilot: Private Pilot Certificate XXXSSNXXX (Airplane Single Engine Land);
was a 5
he was
last six
This pilot was issued a Class 3, Limited Medical Certificate – Must wear corrective lenses.

Pilot reported the following Medications:

- None

List of identified medical, psychiatric, drug or alcohol conditions:

- Last exam – No concerns were reported by the airman and no significant issues were identified by the aviation medical examiner (AME).
- Prior exams - No concerns were reported by the airman and no significant issues were identified by the aviation medical examiner (AME).

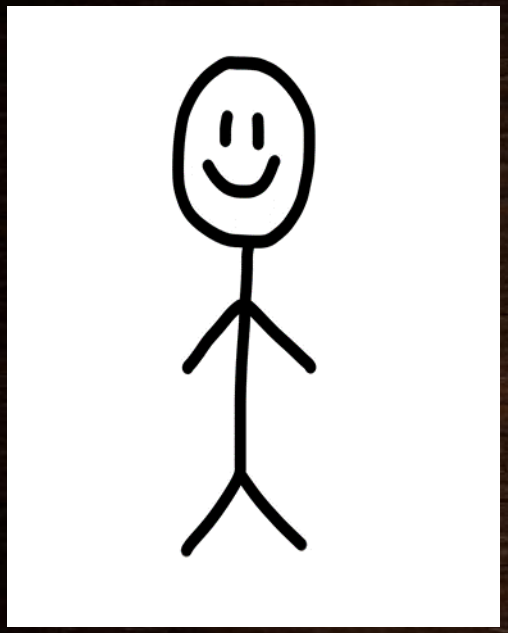
INVESTIGATOR SUBMITTED INFORMATION PILOT: TBD

AUTOPSY PILOT: Pending

TOXICOLOGY PILOT: CAMI REF #

SPECIMENS Bile, Blood (Cavity), Brain, Gastric, Heart, Kidney, Liver, Lung, Muscle, Spleen, Urine, Vitreous
No carbon monoxide was detected in the cavity blood.
Cyanide testing was not performed.
No ethanol was detected in the vitreous.
No Tested-for-Drugs were detected in the urine.
The following clinical tests were reported:

>> **46 (mg/dl) Glucose detected in Vitreous** - Postmortem vitreous glucose levels above 125 mg/dL are considered abnormal
>> **1668 (mg/dl) Glucose detected in Urine** - Postmortem urine levels above 100 mg/dL are considered abnormal



Vacancy

Decision Support Systems - Research Databases and Registries

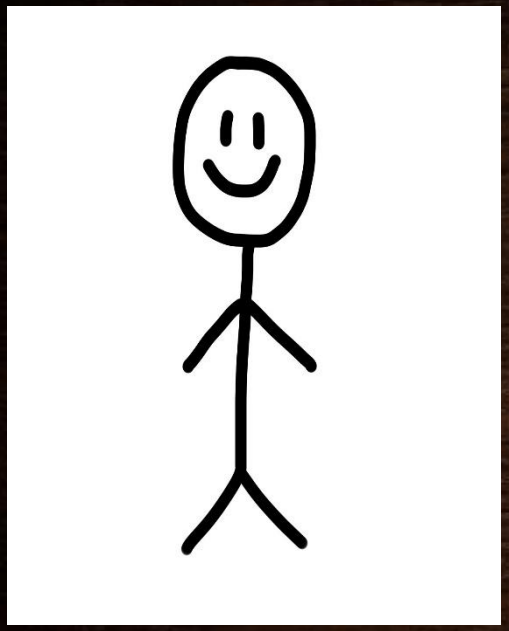
Stacey Zinke-McKee

PROTECTION & SURVIVAL RESEARCH

AAM-630

N= 27 FTEs

LIFE SCIENCES SECTION

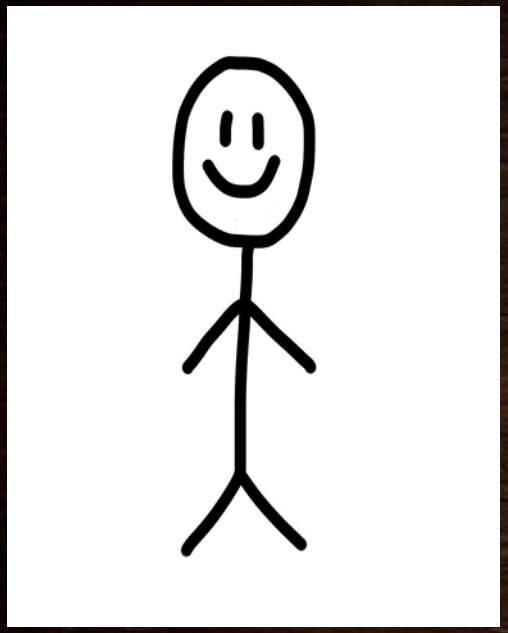


Vacancy

AAM-631

3 Research Teams

AVIATION PHYSIOLOGY RESEARCH TEAM



Vacancy

Environmental Physiology

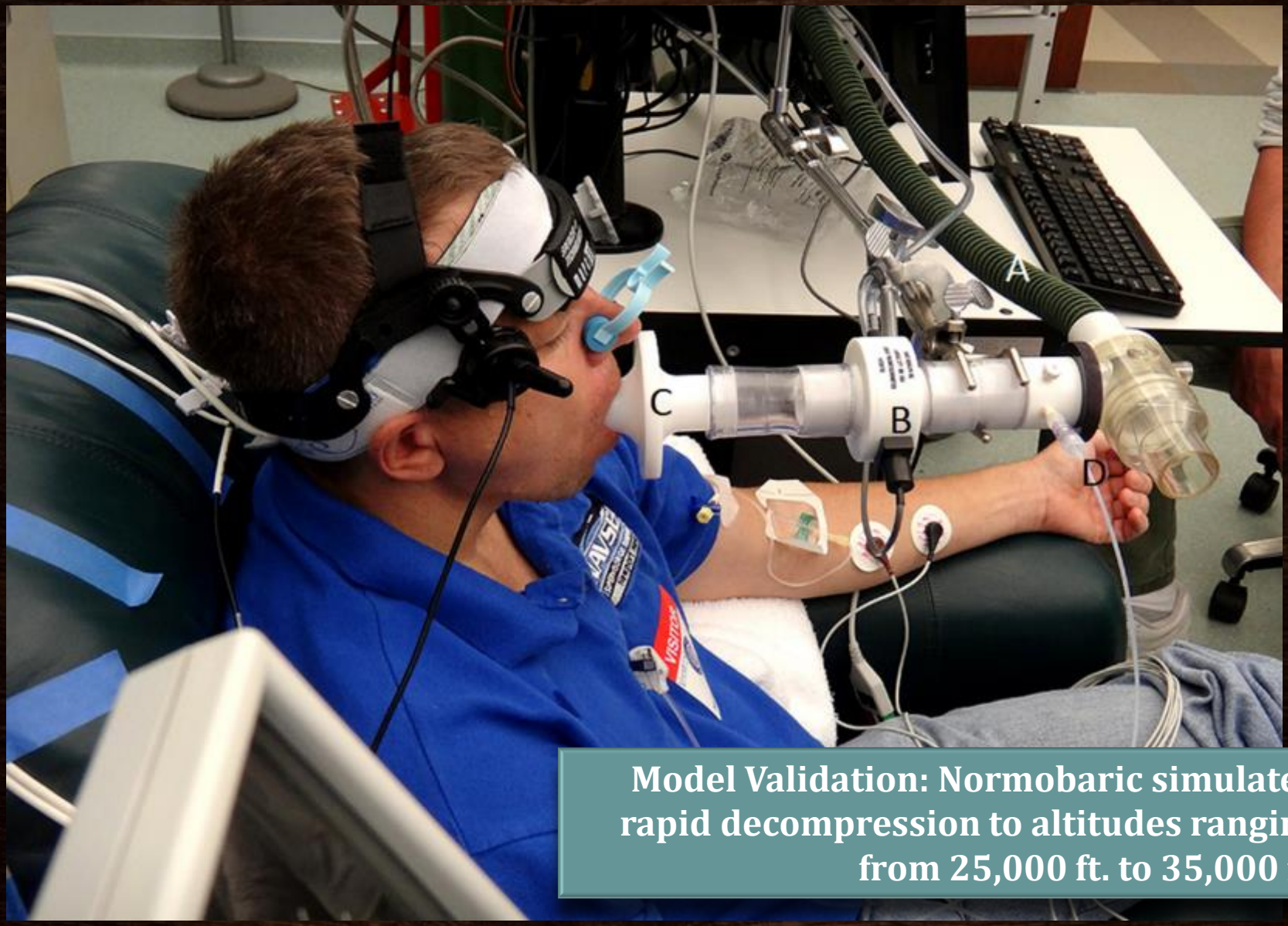
Hypoxia

Human Performance at Altitude

Oxygen Systems

Medical Monitoring and Delivery Devices

Safety of Changes to Operational Ceilings



Model Validation: Normobaric simulated rapid decompression to altitudes ranging from 25,000 ft. to 35,000 ft.

Technology Assessments

The Reduced Oxygen Breathing Device (ROBD) was developed by the US Navy. It simulates the diminished oxygen present at altitude by mixing breathing air and nitrogen under normobaric conditions.

The Portable Reduced Oxygen Training Tent (PROTT) is composed of an inner tent that fits inside an outer tent. The air unit draws in ambient room air and separates the O_2 from the N molecules, creating the hypoxic air. This separation is done in a molecular sieve bed – zeolite traps the O_2 while N flows through.

MEDICAL RESEARCH TEAM

Dr. Chuck DeJohn

Team Lead

Consulting

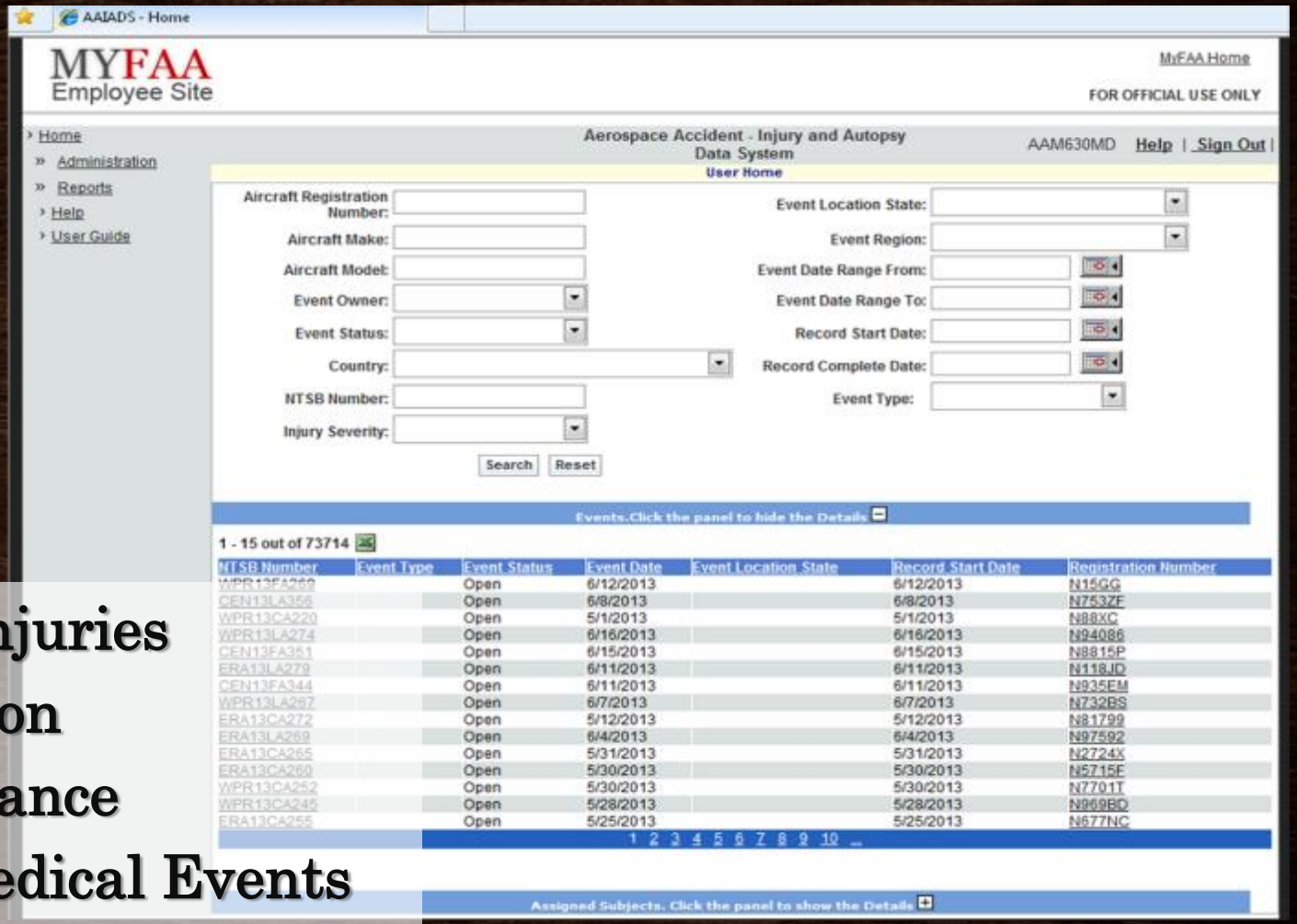
- Immediate Response To Urgent Federal Air Surgeon Queries
- Exploit Own Research Databases and Medical Certification Information
- Assist in the Preparation and Update of Orders (Office Of Aviation Safety and Office Of Accident Investigation)

Aeromedical Accident Investigation

Asiana NTSB Survival Factors Group

- Immediate Response To FAA and NSTB Investigators
- Immediate Review of Medical Records
- Report:
  - Evaluation - Hazards
  - Recommendations
- Implementation:
  - Medical Certification
  - Investigation Practice
  - Research
  - Education

EPIDEMIOLOGY



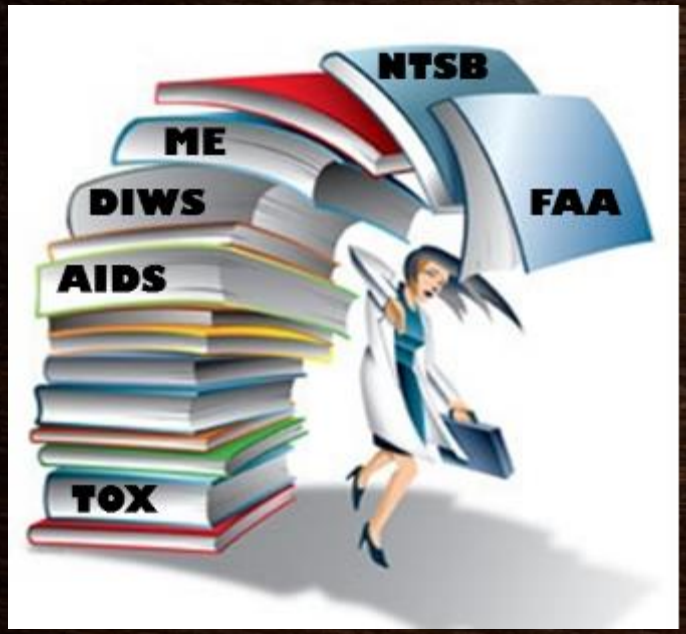
- AA-IADS: Injuries
- Incapacitation
- Special Issuance
- In-Flight Medical Events
- Use of Automated External Defibrillators

Dr. Kyle Copeland

Team Lead

Disparate Data

The integration of mathematical, statistical, and computer methods to analyze and represent biological, biochemical, and biophysical data



Aeromedical Safety Management

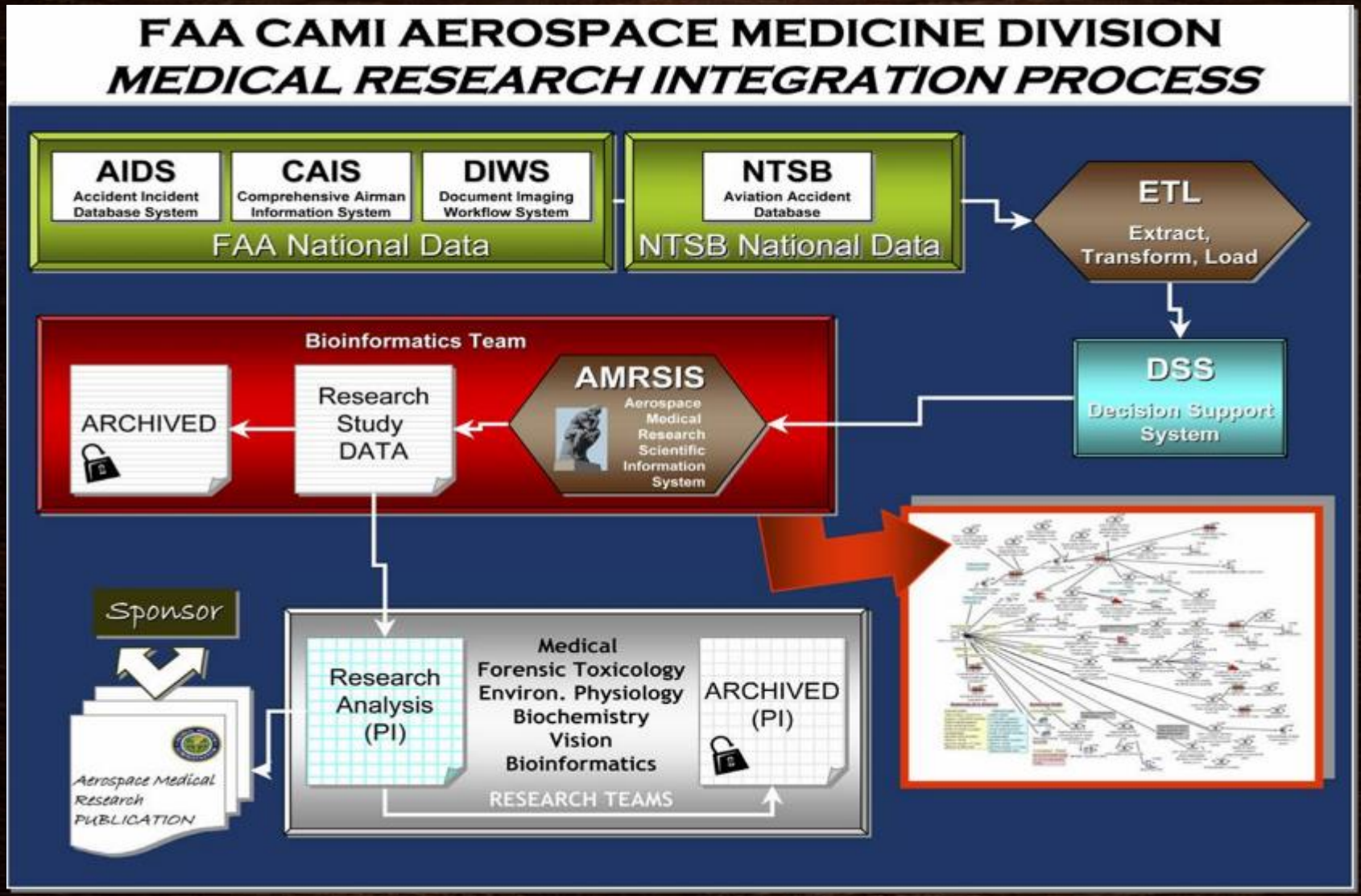
The process:

- Provides a historical foundation to research
- Reduces risk
- Enhances accident investigation practices
- Improves the development of research investment strategies
- Enhances education program goals
- Directly supports medical certification decision-making processes
- Provides a foundation to regulatory language – flight standards and aircraft certification

Probabilistic Risk Assessment

Evidence-Based Medicine

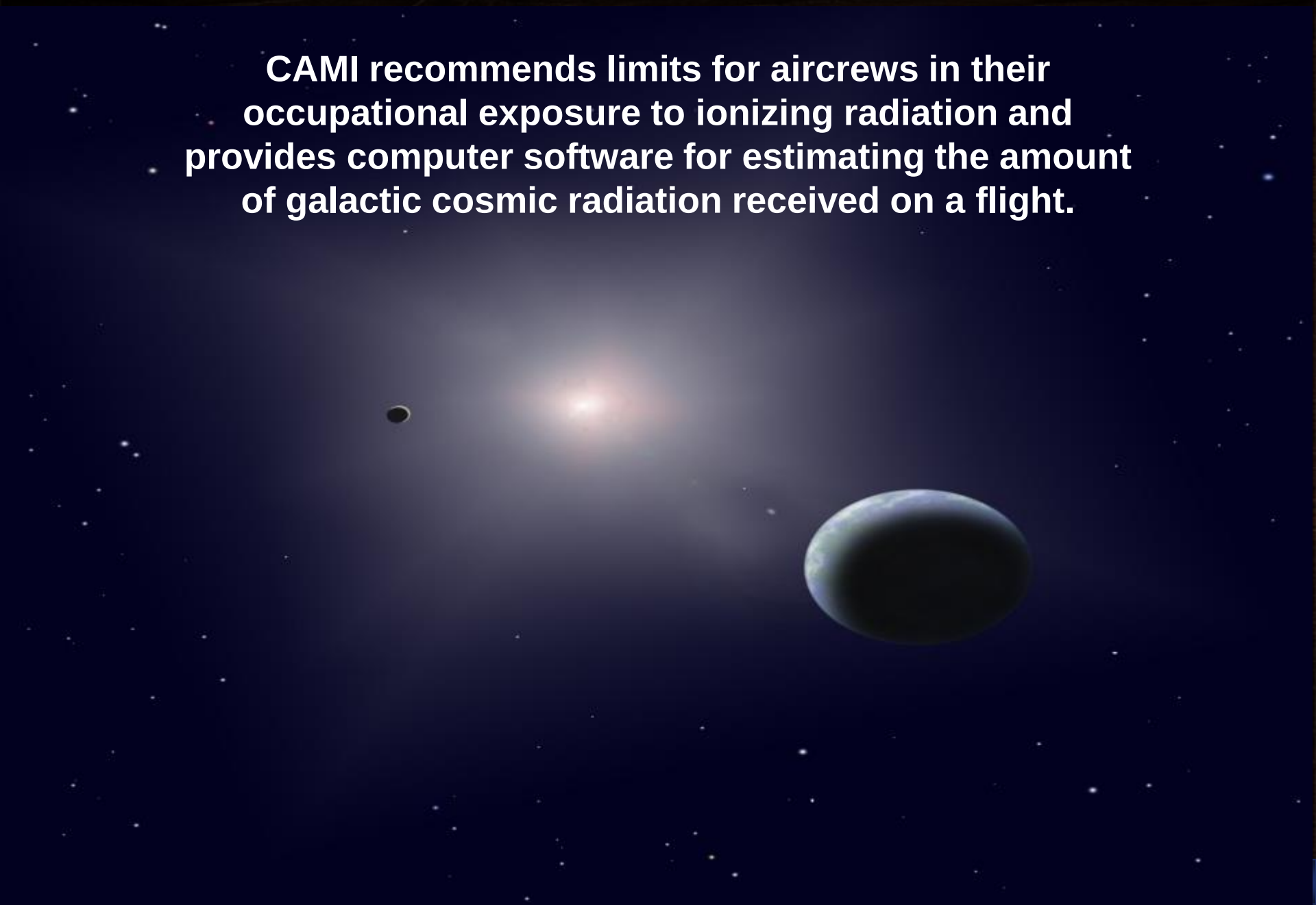
BIG DATA: Scientific Information System



High Performance Computing Capability

Occupational Exposure

CAMI recommends limits for aircrews in their occupational exposure to ionizing radiation and provides computer software for estimating the amount of galactic cosmic radiation received on a flight.



CARI online- *http://jag.cami.jccbi.gov/cariprofile.asp*

FEDERAL AVIATION ADMINISTRATION
OFFICE OF AEROSPACE MEDICINE
CIVIL AEROSPACE MEDICAL INSTITUTE

These forms require a javascript enabled browser.

Left Click on HELP For Instructions
HELP

Galactic Radiation Received In Flight

Enter Flight Data		
Date of Flight	--	01/1995 = January 1995 00/1995 = Average for 1995
Origin Code		- Enter ICAO Code or Look Up Origin Code
Destination Code		- Enter ICAO Code or Look Up Destination Code
Number of en route altitudes		
Minutes to 1st en route altitude		
	Continue	On the next screen you will be asked for en route altitudes, flight times and time spent in final descent..

ENGINEERING SCIENCES SECTION

Rick DeWeese

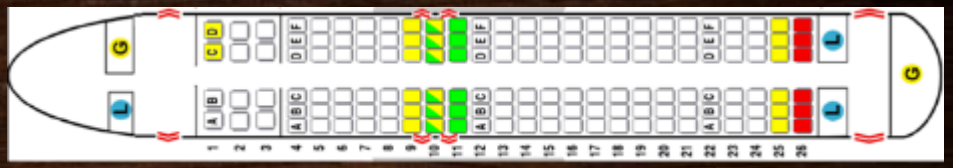
AAM-632

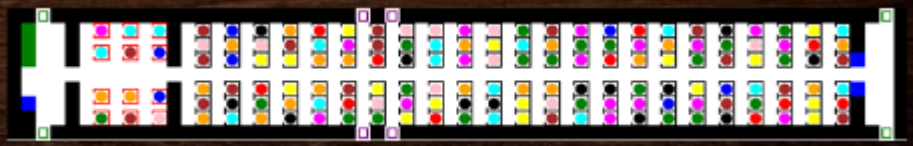
2 Research Teams

David Weed

Team Lead

Cabin Evacuation





Modeling & Simulation

"How tragic to have survived an accident and to be killed while trying to get out of the airplane."

George Black, member, NTSB

Aircraft Cabin Research Facility - ACRF

- Reconfigurable as multiple narrow-body transport category aircraft, (A320, B737, CRJ-700, ERJ170, MD80)
- High-Fidelity Type C, I, and III exits
- Landing gear out pitch-and-roll attitudes
- Emergency scenario management computer system
- Out the window views throughout cabin
- Audio/Video communication
- Environmental control with theatrical smoke
- Staging and storage areas
- Exterior stadium lighting for night time work

B-747 Aircraft Environment Research Facility

Water Survival Research Tank

Comprehension of: SYMBOLS & SIGNS

B-727 Aircraft Fire Laboratory

David Moorcroft

Team Lead

Impact Tests

Airliner

- Air Bags
- Seat Configuration
- Seat Cushions

Business Jet

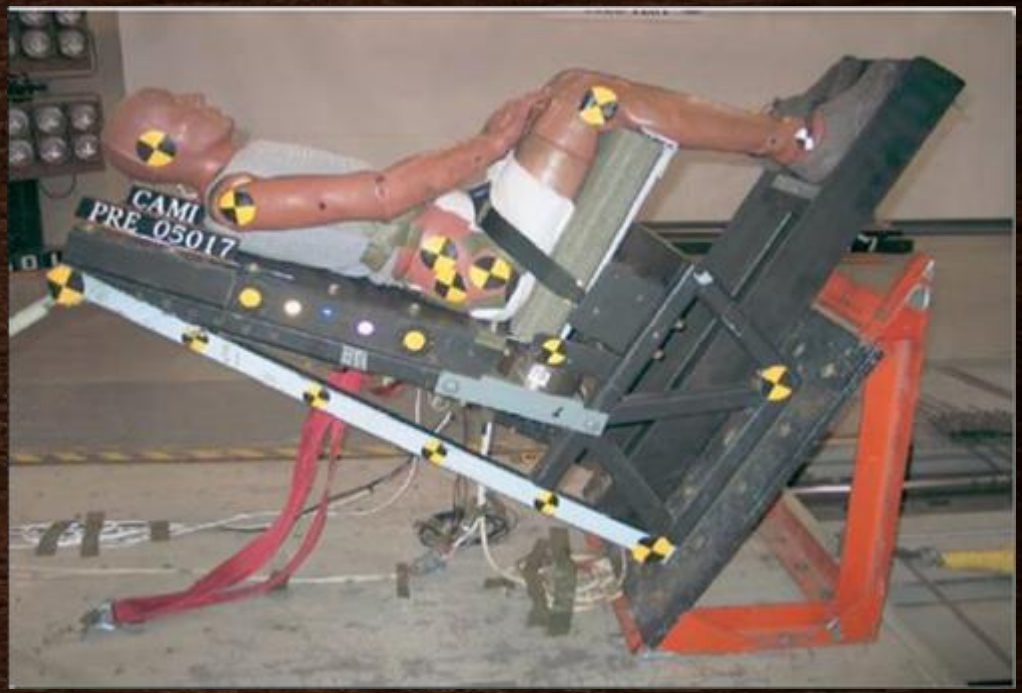
- Restraint Systems
- Life Preservers

Injury Mechanisms

Impact Tests

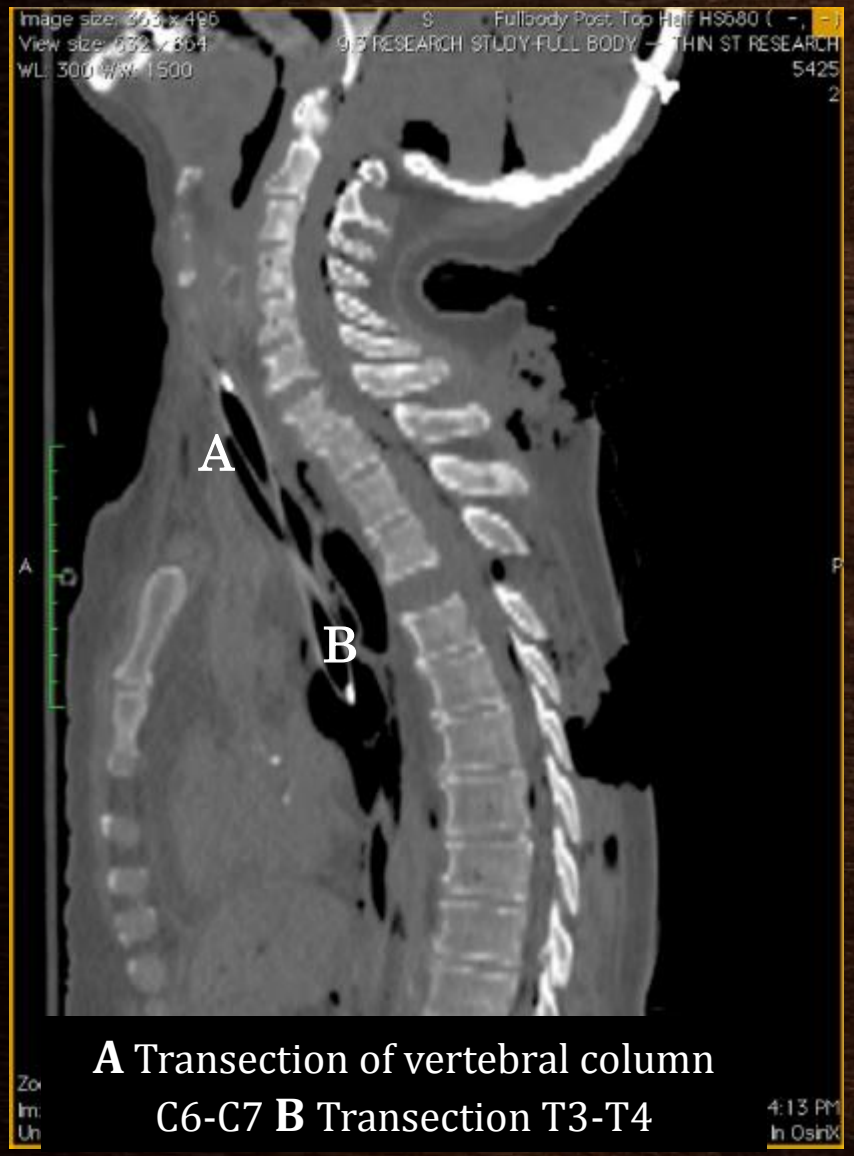
Small Lady

NFL Team

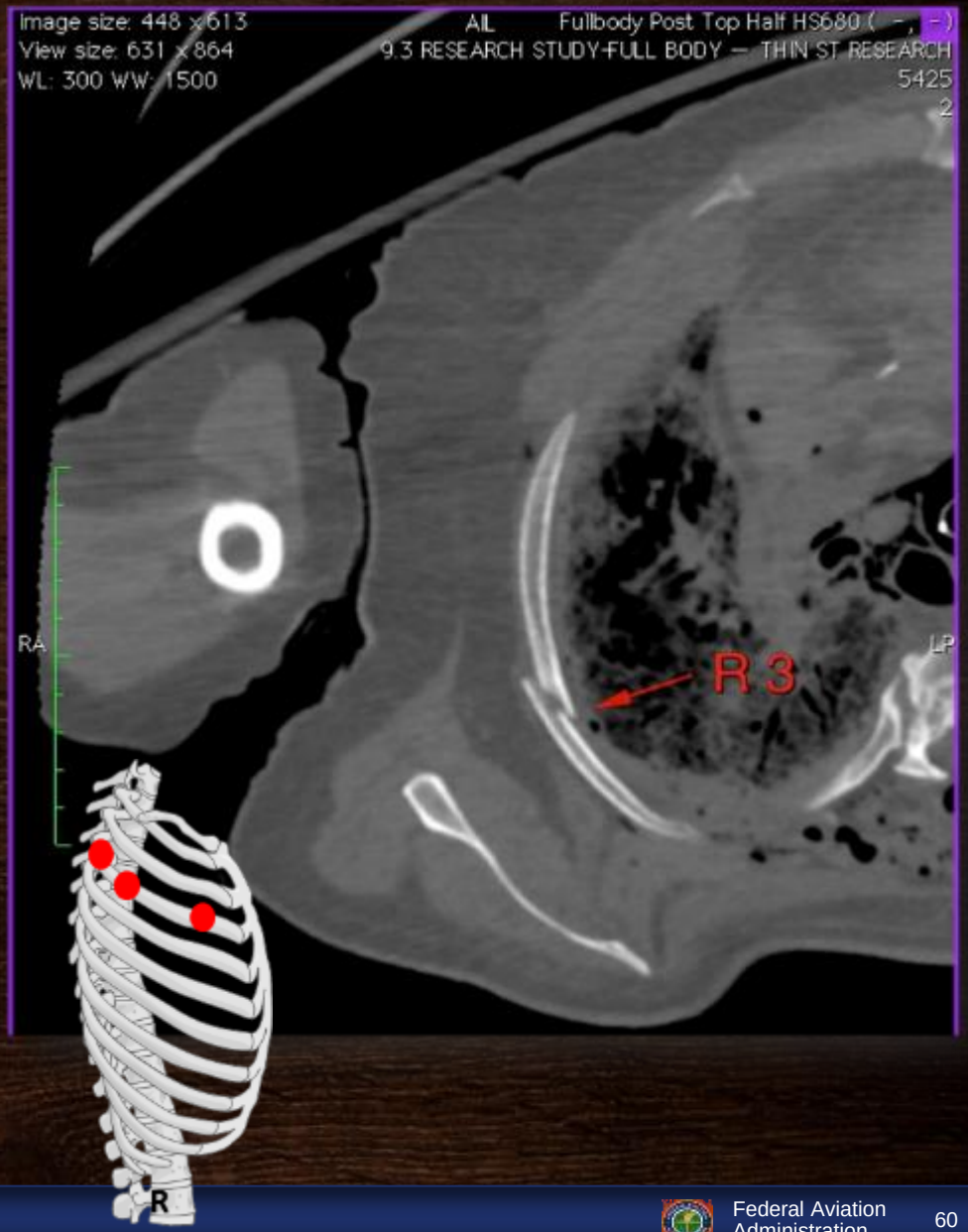


Various Configurations

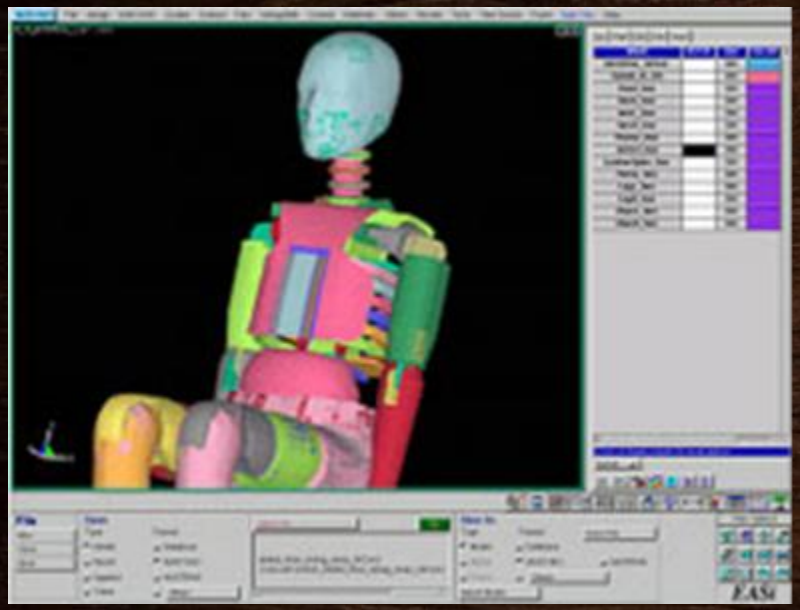
Musculoskeletal Injuries due to Frontal Oblique Impact

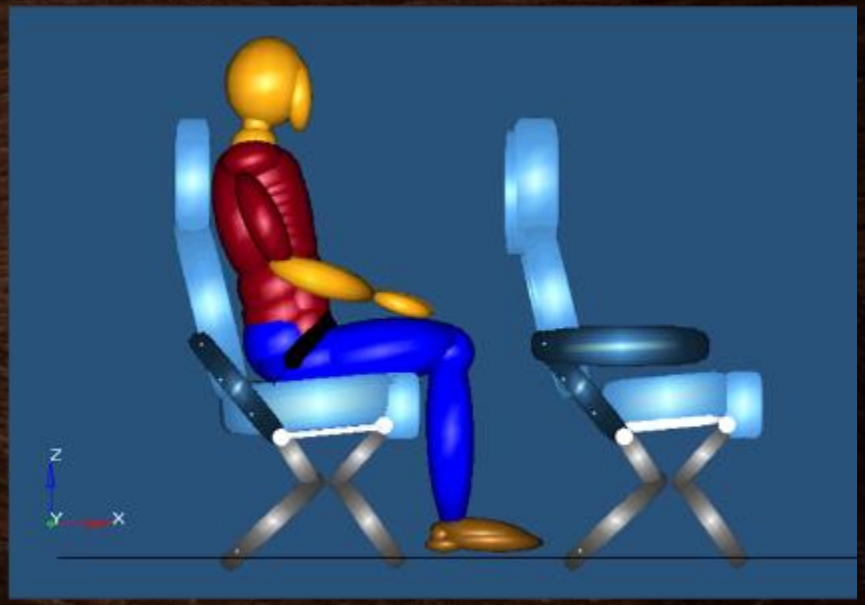


A Transection of vertebral column C6-C7 **B** Transection T3-T4



Modeling & Simulation





Engineering software tools that allow users to design and optimize occupant safety systems efficiently, quickly and cost-effectively.

Using software simulation can predict impact test results as well as save money by simulating different test scenarios, thus reducing the number of actual impact test experiments that consume resources.

Support Certification by Analysis

Expertise in Accident Investigation

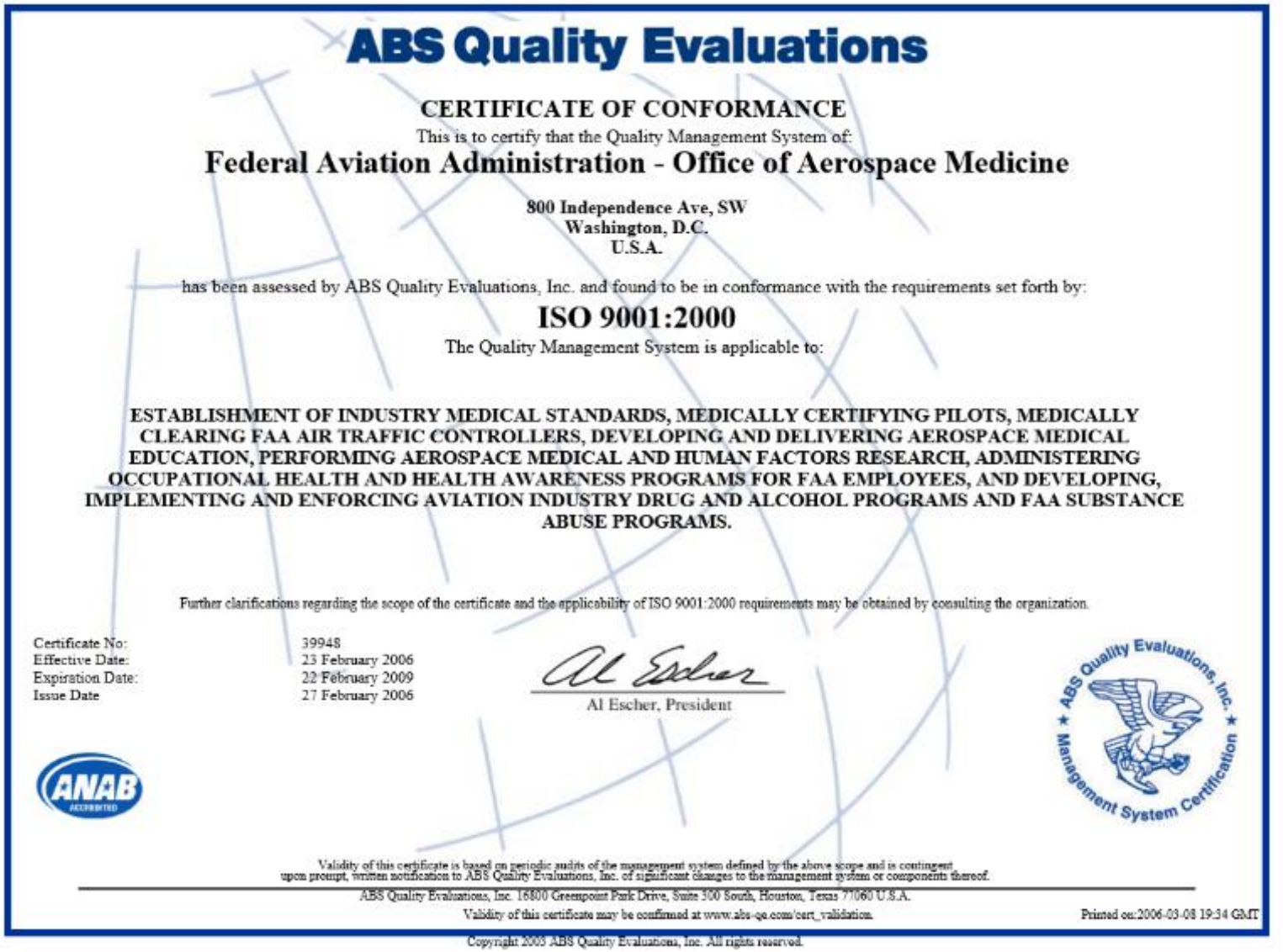
ASIANA, 2013

Turkish Airlines, 2009

Brighton, MI, 2012

Biodynamics Workshops

ISO 9001 Quality Management Systems Certified Since 2006



ABS Quality Evaluations

CERTIFICATE OF CONFORMANCE

This is to certify that the Quality Management System of:

Federal Aviation Administration - Office of Aerospace Medicine

800 Independence Ave, SW
Washington, D.C.
U.S.A.

has been assessed by ABS Quality Evaluations, Inc. and found to be in conformance with the requirements set forth by:

ISO 9001:2000

The Quality Management System is applicable to:

ESTABLISHMENT OF INDUSTRY MEDICAL STANDARDS, MEDICALLY CERTIFYING PILOTS, MEDICALLY CLEARING FAA AIR TRAFFIC CONTROLLERS, DEVELOPING AND DELIVERING AEROSPACE MEDICAL EDUCATION, PERFORMING AEROSPACE MEDICAL AND HUMAN FACTORS RESEARCH, ADMINISTERING OCCUPATIONAL HEALTH AND HEALTH AWARENESS PROGRAMS FOR FAA EMPLOYEES, AND DEVELOPING, IMPLEMENTING AND ENFORCING AVIATION INDUSTRY DRUG AND ALCOHOL PROGRAMS AND FAA SUBSTANCE ABUSE PROGRAMS.

Further clarifications regarding the scope of the certificate and the applicability of ISO 9001:2000 requirements may be obtained by consulting the organization.

Certificate No:	39948
Effective Date:	23 February 2006
Expiration Date:	22 February 2009
Issue Date	27 February 2006

Al Escher, President

ANAB ACCREDITED

ABS Quality Evaluations, Inc. ★ Management System Certification ★

Validity of this certificate is based on periodic audits of the management system defined by the above scope and is contingent upon prompt, written notification to ABS Quality Evaluations, Inc. of significant changes to the management system or components thereof.

ABS Quality Evaluations, Inc. 16800 Greenspoint Park Drive, Suite 300 South, Houston, Texas 77060 U.S.A.

Validity of this certificate may be confirmed at www.abs-qe.com/cert_validation. Printed on:2006-03-08 19:34 GMT

Aeromedical Products & Services

• Medical and Engineering Certification Criteria • Certification Testing Standards • Simulation & Modeling Tools • Predictive Safety Algorithms • Risk Analysis Models • Advisory & Regulatory Language • Scientific and Engineering Peer-Reviewed Manuscripts • Cabin Safety and Biodynamics Workshops • Technical Reports • Integrated Medical Research Databases • National Aircraft Accident Autopsy Database • Aeromedical Data Visualization Operational Reporting Safety System • Aeromedical Screening Technology Evaluations • Aircraft Accident Aeromedical Review Reports • Emergency Aeromedical Review Consultations • Aeromedical Certification Quality Control Tools • Freedom of Information Act Reports • Affidavits • Court Testimony • Certified Laboratory Procedures and • Proficiency Testing Programs.

Aeromedical Sponsors and Stakeholders

Aviation Medicine (reports, publications, safety recommendations)

Accident Investigation (accident causation, countermeasures)

Aircraft Certification (seats, restraints, protective equipment)

Flight Standards (evacuation, survival, cabin safety, human factors)

General Counsel (affidavits, court testimony)

Mentorship, Collaboration, and Partnerships

Students (undergraduate, graduate, thesis & dissertations)

Scientists (fellowships, sabbaticals – NRC/NIH)

Physicians (AMEs, RAMs)

Industry (contractual, workshops, MOA/MOU, CRADAs)

Military (collaborative studies, research, facilities)

Academia (research subjects, grants, facilities, expertise)

Government (Fire, Hwy, FEMA, NASA, NOAA, DHS, K-9, SCUBA)

U.S. and Other Nations

SUMMARY

Aeromedical Research:

Supports FAA regulatory and advisory missions to improve the safety, security, health, and survivability of the most important component of the NAS: the human operator and the public which s/he serves.

Thank You

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