

FIT FOR FLYING



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2010 PRINTING
**Davis Direct
Montgomery, AL**

FIT FOR FLYING



Educational Programs Directorate
Drug Demand Reduction (DDR) Program

Civil Air Patrol National Headquarters
105 South Hansell Street
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The DDR Message

Throughout this book, the reader will see many references to drugs, alcohol, and physical fitness as they relate to becoming and remaining a pilot. These passages will be highlighted in yellow to raise the awareness of how the aviation industry has a zero tolerance for drugs and substance abuse.

National Academic Standard Alignment

National Science Standards: (National Research Council –
(http://www.nap.edu/openbook.php?record_id=4962) :

Content Standard B: Physical Science

- Motions and forces

Content Standard C: Life Science

- Diversity and adaptations of organisms

Content Standard E: Science and Technology

- Abilities of technological design
- Understandings about science and technology

Content Standard F: Science in Personal and Social Perspectives

- Personal health
- Natural hazards
- Risks and benefits
- Science and technology in society

Content Standard G: History and Nature of Science

- Science as a human endeavor
- History of science

Unifying Concepts and Processes

- Form and function

National Physical Education Standards: (National Association for Sport and Physical Education –
(<http://www.aahperd.org/naspe/standards/nationalStandards/PEstandards.cfm>)

Standard 5: Exhibits responsible personal and social behavior that respects self and others in physical activity settings.

Standard 6: Values physical activity for health, enjoyment, challenge, self-expression, and/or social interaction.

National Character Education Standards: (Character Education Partnership –
(<http://www.character.org/qualitystandards>)

Principle #1: Effective character education promotes core ethical values as well as supportive performance values as the foundation of good character.

Principle #2: Effective character education defines “character” comprehensively to include thinking, feeling, and behavior.

Principle #3: Effective character education uses a comprehensive, intentional, and proactive approach to character development.

Principle #5: Effective character education provides students with opportunities for moral action.

Principle #6: Effective character education includes a meaningful and challenging academic curriculum that respects all learners, develops their character, and helps them succeed.

Principle #7: Effective character education strives to develop students’ self-motivation.

Principle #8: Effective character education engages the school staff as a learning and moral community that shares responsibility for character education and attempts to adhere to the same core values that guide the education of students.

Principle #9: Effective character education fosters leadership and long-range support of the character education initiative.

National Health Education Standards: (American Cancer Society –
(<http://www.cancer.org/Healthy/MoreWaysACSHelpsYouStayWell/SchoolHealth/national-health-education-standards-2007?sitearea=PED>)

Standard 4: Students will demonstrate the ability to use interpersonal communication skills to enhance health and avoid or reduce health risks.

Standard 5: Students will demonstrate the ability to use decision-making skills to enhance health.

Standard 6: Students will demonstrate the ability to use goal-setting skills to enhance health.

Standard 7: Students will demonstrate the ability to practice health-enhancing behaviors and avoid or reduce health risks.

National Career Development Guidelines: (National Occupational Information Coordinating Committee commissioned by the US Department of Education's Office of Vocational and Adult Education - http://www.hollandcodes.com/national_career_development_guidelines.html)

Domains affected by this publication are:

Personal Social Development Domain

- Develop understanding of yourself to build and maintain a positive self-concept
- Develop positive interpersonal skills including respect for diversity
- Integrate personal growth and change into your career development

Educational Achievement and Lifelong Learning Domain

- Attain educational achievement and performance levels needed to reach your personal and career goals
- Participate in ongoing, lifelong learning experiences to enhance your ability to function effectively in a diverse and changing economy

Career Management Domain

- Use a process of decision-making as one component of career development
- Use accurate, current, and unbiased career information during career planning and management

Introduction

FIT FOR FLYING has been written as a cooperative effort between the Civil Air Patrol Drug Demand Reduction Program, a component of Cadet Programs, and the Aerospace Education and Missions Divisions. This book provides young people, as well as, entry-level and experienced pilots, with information concerning the primary importance of FAA medical certification to be fit for flying. Throughout the aviation community, it is a well-known fact that the medical certificate is equal to a pilot's license, now also called a certificate. Without medical certification, a pilot simply cannot legally fly.

The actual in-flight operation of an aircraft requires high performance flying skills or "airmanship." The first unit of *FIT FOR FLYING*, is called "Human Airworthiness." This entire publication details how to maintain all airworthiness skills with good health and a dedication to a clean, drug-free lifestyle. The reader is also made aware of other issues that have the potential of compromising human performance. These include altitude problems within the flight environment, over-the-counter drugs, and improper diet, just to mention a few.

In the first DDR publication, *LET'S GO FLYING*, there was a fascinating and informative "behind-the-scenes" overview of commercial, general, and military aviation. There was also a clear message about the aviation world's zero tolerance toward drug and alcohol abuse. Professional pilots from business, commercial, and military aviation were interviewed. Their personal accounts gave the reader a comprehensive look at the importance of developing and maintaining a body that needs to be "airworthy" throughout the entire career of a pilot. In essence, the *LET'S GO FLYING* book prepared the younger aviation enthusiast, who had a fascination for flight, for the reality of what it takes to become an aviation professional.

Special recognition must be given to thousands of CAP pilots and observers who put their lives on the line every time they volunteer to participate in a mission for the Emergency Services program. There are two individuals who made major contributions to this publication and deserve a very special recognition. The first is given to CAP Col Sharon Taylor for her tireless effort to promote a healthy lifestyle and laying the foundation for programs such as "health walks" at CAP functions. Secondly, a special recognition goes to Dr. Robert Sancetta, M.D., who made it possible for thousands of pilots to overcome "the impossible," and return to active flight status. He is truly one of America's finest Aviation Medical Examiners. This book is dedicated to both of these outstanding professionals.

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PART ONE

— The Airworthy Human —





*1.1 Captain Cory Von Pinnon has maintained a lifestyle of physical fitness, constant study and a dedication to his career as a corporate pilot for AvantAir.
(Picture courtesy of Capt. Cory Von Pinnon)*

Setting the stage: Advice about fitness and flying

An airworthy lifestyle is the key to becoming a pilot. Captain Cory Von Pinnon, a corporate pilot for AvantAir, explains this concept. “The human body is fragile and when we fly, we are working in an environment for which our bodies weren’t designed. To combat that, I stay well hydrated, since most pressurized airplanes are quite dry. I eat healthy and hit the gym a few times a week just to keep my body strong. As pilots, we routinely fly in the 30,000 to 40,000 foot range where a loss of pressurization gives a healthy pilot less than 30 seconds of useful consciousness. The body is highly susceptible to oxygen deprivation due to low air pressure in the upper atmosphere. This susceptibility is higher for those who smoke. I used to smoke, but I stopped in order to stay physically fit to be a pilot. I take my health seriously. As a professional pilot, I must get an aviation physical every year. If, for some reason, I could not pass my physical, I would be unable to fly. I’ve worked too long and too hard to run that risk. It’s an incredible career and I don’t want to be grounded due to a failed medical exam.”



1.2 Captain Cory Von Pinnon flies the stunning Piaggio Avanti II over Lake Tahoe. (Image courtesy of AvantAir and air-to-air photography was done by John Parker)

What does a physical examination have to do with taking flying lessons?

Fast forward to a scene that takes place at an airport located on the outskirts of a mid-sized American city. Tyler, a 16 year-old boy, and his parents are visiting a flight school and are asked to be seated in the flight manager's office. Just as the boy takes one of the chairs, the door opens and a man in his mid forties walks into the room. He introduces himself as Dave Bolling, the manager of the flight school. Tyler's father, Randy, introduces himself; his wife, Karen; and his

1.3 Captain Von Pinnon's "office" is the instrument panel of the Piaggio P180 Avanti. The aircraft has two Pratt & Whitney PT6A turbo-prop engines putting out 850 shaft horsepower (SHP) each. The aircraft has a maximum speed of 455 mph (395 knots) and a service ceiling of 41,000 feet. The P180 has a two-pilot crew and seats up to nine passengers. (Photo from AvantAir)





1.4 The airplane of choice for many flight schools is the Cessna 172 Skyhawk. It is easy to fly, handles well on the ground, and is very “pilot-friendly” in the air (Photography is by Adam Wright, Flight Officer for Atlantic Southeast Airlines)

son. Randy expresses the interest his son has had in flying since he was six years old. He explains that he and his wife have tried to support him as much as they could; starting four years earlier putting money aside for flight training. They are now ready to get their son started on realizing his dream.

The flight manager asks Tyler if he is in good physical health. He tells Tyler that the first thing he will have to do is to get a flight physical. Tyler’s father is taken by surprise and asks what a physical examination has to do with taking flying lessons. The flight school manager says that all pilots must be physically fit to fly an airplane, and that both a medical certificate and a pilot’s certificate are needed to fly. Tyler’s father states that his son plays lacrosse and has had no problem passing the athletic physicals each year. He asks the flight manager if the standards for the aviation medical exam are any different.

Flight Manager Bolling says that if Tyler is in good physical shape, he should probably not have a problem meeting the medical exam requirements. He further states that he talks to a lot of people who are interested in becoming pilots and want to know how fit they have to be to fly and who determines what is acceptable health. Bolling states that the Federal Aviation Administration (FAA) sets the standards for pilots. He says that the history of the FAA goes back to 1926. Over the years, this U.S. governmental agency has developed

the highest standards for flight training, medical evaluation, and air traffic control. As a result, Bolling states that the United States has the safest airway system in the world.

NOTE: Since the beginning of the 20th Century, the formal document stating that a person is a trained aviator was known as a pilot's "license." In the latter part of the 20th century, the FAA changed the designation to "certificate." The medical document is also called a "certificate." To a beginner, this can be confusing. It is going to take awhile before the public stops referring to pilot certification as a "license," but in this book the correct term of certificate will be used for both the pilot and medical certificates.

Bolling continues to say that after Tyler passes and receives his medical certificate, he will then start out being taught the basics of aviation and flight. Then, at some point along the way, usually within the first 10-20 hours of flight training with the instructor, he will be given the opportunity to take the airplane up without the instructor for his solo flight. Bolling tells Tyler and his parents that ultimately it is not the flight instructor or the FAA administrator who issues the first pilot's certificate. It is a medical doctor.

Bolling says that Tyler will be required to get a Third Class medical examination for his student pilot certificate. This is the entry level of the three classes of the FAA's medical examinations.

A **Third Class Medical Certificate** is valid for five years, unless the individual is over 40 years old, wherein the medical certificate is valid for only two years. A **Second Class Medical Certificate** is valid



*1.5 Cessna has entered the light sport aircraft market with its new "Skycatcher."
(Images courtesy of Cessna Aircraft Company)*

for one year, regardless of age. A **First Class Medical Certificate** is valid for one year, unless the applicant is over 40 years old, then the duration is six months.

A student pilot starts by getting a Third Class Medical examination. Students who have physical limitations, such as impaired vision or hearing problems, or even loss or limited use of a limb, may be issued a medical certificate valid for “student pilot privileges only” while they are learning to fly. Some disabilities may require special equipment installed in the airplane, such as hand controls for pilots with paraplegia. In special disability cases, when all the knowledge, experience, and proficiency requirements have been met and a student can demonstrate an ability to operate the airplane with a normal level of safety, a Statement of Demonstrated Ability (SODA) can be issued by the FAA. The SODA is a waiver that is valid as long as the pilot’s physical conditions remain the same. Bolling tells Tyler that since he doesn’t have any recognizable problems, he should pass his Third Class Medical examination without any problems.

Bolling emphasizes that if Tyler is sure he wants to fly, whether just for fun or as a professional, he will have to accept the reality that he must stay healthy enough to regularly pass a physical examination as long as he flies. The pilot’s certificate and the medical certificate must be considered with the same importance. Federal Aviation Regulations state that a pilot must carry a current medical certificate to act as the pilot-in-command of an airplane.

The flight school manager says that if Tyler wants to become a pilot, he has to make a commitment right from the beginning to stay in top physical condition for the rest of his life. Every time he climbs into the cockpit of an airplane, he has to be in the same, or better, condition than he was when he took his last medical exam. This also means he shouldn’t abuse drugs and alcohol if he wants to be a pilot.

Tyler and his parents know that their son now has a reason for staying fit, staying away from drugs, and staying away from alcohol. After hearing this explanation, Randy looks at Tyler’s mother and states that this is the best anti-drug message he’s ever heard. Alcohol and drug abuse can directly affect the outcome of a physical exam and failing the medical test could end a pilot’s career goal in life.

As the interview comes to an end, Dave Bolling says that he has an excellent instructor that Tyler would like. He says that he could get Tyler scheduled for flight training that week and that he can get the paperwork and a list of doctors who can administer the FAA physical immediately. The dream begins!

Randy gives his son a nudge on his shoulder and says, “Hey, who



1.6 Passengers take for granted that their crew is in top physical condition as they soar through the skies to their next destination for business or for pleasure.

(Photo by Ben Wang; released by Airliners.net)

knows? Sometime in the future, we may hear a special announcement saying, ‘Good morning ladies and gentlemen. This is Captain Tyler Ammons and it looks like we’re going to have blue skies all the way to Orlando and Sea World.’ ”

The FAA’s aeromedical responsibilities

The medical division is an extremely important component of the FAA. It is called the Civil Aerospace Medical Institute (CAMI) and it is located in Oklahoma City, Oklahoma. This facility serves over 600,000 pilots in a calendar year:

- receiving more than 435,000 airman examinations annually,
- processing more than 1,800 applications per day,
- processing more than 30,000 special case exams annually,
- processing more than 175,000 telephone calls annually,
- generating more than 75,000 individual letters to airmen,
- issuing duplicate medical certificates and
- reviewing medical records for the purpose of issuing an “Authorization for Special Issuance.”

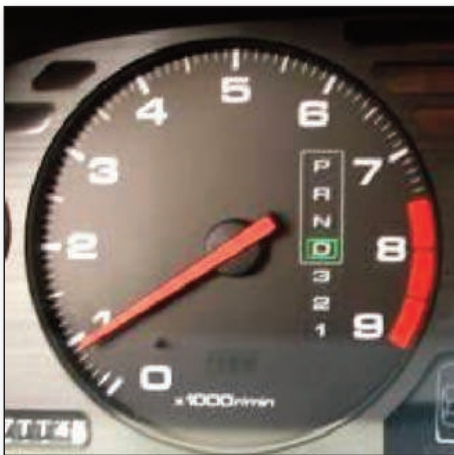
CAMI’s objective is “to ensure that only those pilots who are physically and mentally fit will be authorized to operate aircraft, thereby enhancing aviation safety by eliminating the medical factor as a cause of aircraft accidents.”



1.7 Dr. Warren Silberman is the manager of the FAA CAMI facility in Oklahoma City. His decisions affect the lives of thousands of pilots.

What is the definition of “airworthy?”

“Airworthy” by definition, means “fit to fly” from a human performance or physiological standpoint. So, who determines the meaning of “fit?” The answer is, of course, the Federal Aviation Administration. The physicians at CAMI have developed a test that the 3,927 civilian Aviation Medical Examiners (AMEs) use as the instrument to determine who is fit for flying. The test is administered on what is known as Form 8500-8. (You will read more about the Form 8500-8 throughout this text.) According to the FAA, passing this examination will give medical authorities a reasonable prediction that within the duration of the medical certificate’s validity a sudden, incapacitating medical event should not be a probability.



*Throughout the Fit for Flying text, the reader will see the word **(REDLINE)**. This indicates a very important word or statement and needs special attention.*

Meet the Civil Air Patrol's medical advisor, Robert Sancetta, MD



1.8 Dr. Robert Sancetta holding a scale model of the DC-10 he flew for Gemini Air Cargo. He holds the following titles: Medical Doctor (MD), Aviation Medical Examiner (AME), Airline Transport Pilot (ATP), and Certified Flight Instructor, Instrument rating (CFII).

The Civil Air Patrol has been given the privilege of having one of the foremost Aviation Medical Examiners (AMEs) in the United States advise and help CAP understand what it means to be a pilot who is healthy and physiologically safe. Not only is he a practicing physician, but Dr. Sancetta also has an Airline Transport Pilot Certificate, and, until recently, was a DC-10 Captain. He is also a certificated Flight Instructor Instrument (CFII). This highly qualified AME has

agreed to help CAP members better understand what it means to be “fit for flying” by using an FAA physical examination test instrument known as the 8500-8.

Dr. Sancetta was asked to first give readers an overview of his background. He said, “I came from a family of Italian immigrants who moved to America so my father could become an American-trained doctor. My father worked as a surgeon for the United States military in VA hospitals here in the states. After completion of his military commitment, we settled in New York and he established a private medical practice. My mother raised the children and then had a successful career as a talent agent. She, like my father, was a great role model for me.

As a kid, I always had a love of airplanes, but it never occurred to me that I could become a pilot. Every time the family got together, they told me, ‘you’re going to be a doctor just like your father.’

When the time came, I elected to go to college and take my pre-medical training at the University of Colorado in Boulder.

On the trip out to Colorado, the day before my freshman orientation, I decided to stay the night in Lincoln, Nebraska. The airport was close by the motel, and, just on a whim, I went over and took a flight in a Cessna 150. That ‘discovery flight’ forever changed my life. I made the decision then and there that I was going to learn how to fly. Over the next several years, I had my regular schedule of pre-med coursework, and I supplemented the expense of my flying lessons by cutting lawns and being a busboy in a restaurant.

Once I graduated from the University of Colorado, I continued working on getting the certificates and ratings necessary to become a professional pilot. This was back in the 1970s and 1980s, and eventually I was hired by Frontier Airlines. It was the best of times. I was 30 years old, living in Colorado, and flying 737s.

Then a bid to combine Frontier with United Airlines failed, and Denver-based Frontier went out of business. Most of the pilots, me included, were absorbed by Continental Airlines. They were an excellent and financially-strong company; however, the Denver base was eventually closed. I ‘commuted’ for a while, but it didn’t take long for me to figure out that I didn’t want to leave Boulder. That’s when the dream of becoming a doctor came back to life.

I applied for, and was accepted by, the University of Colorado Medical School. I finished the rigorous training and elected to take the route of being a family physician; however, the love of aviation still had a great influence on my life, and I became an Aviation Medical Examiner (AME) while I was still a resident physician.

In 1997, I found that helping pilots who had been grounded became very important to me. I decided that I could do FAA medical examinations full time and still have time to be a pilot. Various opportunities came up for me to fly professionally, and, by working the exams around flight scheduling, I was able to do both. I worked hard to maintain a high degree of physical fitness (running marathons and hiking the trails west of Boulder) and was able to keep the pace going for many years. I was fortunate to be able to fly several wonderful airplanes. These included the Beechcraft *King Air*, the Hawker 800, and a Gulfstream *G-4*. Finally, I reached the pinnacle of my flying career when I was hired by Gemini Air Cargo, eventually becoming Captain on their *DC-10s*. Just recently, the company went out of business and I decided to devote all of my time and efforts to FAA medical examinations and helping pilots who had been grounded.

Along with my full-time AME practice, I also have an interna-



1.9 DC-10 Captain Robert Sancetta, Gemini Air Cargo

tional consulting service for pilots with special medical conditions. In some cases, I have been doing special issuance protocols for pilots I've never met. (*A "Special issuance" is a waiver for a disqualifying condition.*) On the average, I see between 80-100 pilots per month in my office. I also have quite a large number of cases requiring a special issuance disposition (where a decision has to be made regarding whether or not the pilot can return to flight status) after a significant illness or medical procedure. My practice is time-consuming but also very rewarding. It is truly a labor of love and dedication."

The FAA medical examination – Form 8500-8

The Form 8500-8 FAA medical examination is available to the public online. The Airplane Owners and Pilots Association (AOPA) has this form and many other FAA publications on its excellent web site, <http://www.aopa.org/members/files/medical/8500-8.pdf>. Due to space constrictions, reduced copies of both pages of the Form 8500-8 are used in this text. Page 1 of the 8500-8 form can be filled out by the pilot either by hand at the AME's office, or on-line in advance via the new FAA MedXpress system. Page 2 is the physician's examination report; all exam data must now be transmitted electroni-

Applicant Must Complete ALL 20 Items (Except For Shaded Areas) PLEASE PRINT Form Approved OMB NO. 2120-0034

Copy of FAA Form 8500-8 (Medical Certificate) or FAA Form 8425-2 (Medical/Student Pilot Certificate) issued: **GG-1457428**

MEDICAL CERTIFICATE CLASS AND STUDENT PILOT CERTIFICATE

This certifies that (Full name and address):

Date of Birth: _____ Height: _____ Weight: _____ Hair: _____ Eyes: _____ Sex: _____

has met the medical standards prescribed in part 67, Federal Aviation Regulations, for this class of Medical Certificate.

1. Application For: Airman Medical Certificate Airman Medical and Student Pilot Certificate **2. Class of Medical Certificate Applied For:** 1st 2nd 3rd

3. Last Name _____ **First Name** _____ **Middle Name** _____

4. Social Security Number _____

5. Address _____ Telephone Number () _____

Number / Street _____

City _____ State / Country _____ Zip Code _____

6. Date of Birth M M / D D / Y Y Y Y **7. Color of Hair** _____ **8. Color of Eyes** _____ **9. Sex** _____

10. Type of Airman Certificate(s) You Hold: None ATC Specialist Flight Instructor Recreational Airline Transport Flight Engineer Private Other Commercial Flight Navigator Student

11. Occupation _____ **12. Employer** _____

13. Has Your FAA Airman Medical Certificate Ever Been Denied, Suspended, or Revoked? Yes No If yes, give date, M M / D D / Y Y Y Y

Total Pilot Time (Civilian Only) _____ **16. Date of Last FAA Medical Application** M M / D D / Y Y Y Y No Prior Application

14. To Date _____ **15. Past 6 Months** _____ No Yes (If yes, below list medication(s) used and check appropriate box) Yes No

17.a. Do You Currently Use Any Medication (Prescription or Nonprescription)? No Yes (If yes, below list medication(s) used and check appropriate box) Yes No

17.b. Do You Ever Use Near Vision Contact Lens(es) While Flying? Yes No

18. Medical History - HAVE YOU EVER IN YOUR LIFE BEEN DIAGNOSED WITH, HAD, OR DO YOU PRESENTLY HAVE ANY OF THE FOLLOWING? Answer "yes" or "no" for every condition listed below. In the EXPLANATIONS box below, you may note "PREVIOUSLY REPORTED, NO CHANGE" only if the explanation of the condition was reported on a previous application for an airman medical certificate and there has been no change in your condition. See Instructions Page

Yes	No	Condition	Yes	No	Condition	Yes	No	Condition	Yes	No	Condition
<input type="checkbox"/>	<input type="checkbox"/>	Frequent or severe headaches	<input type="checkbox"/>	<input type="checkbox"/>	Heart or vascular trouble	<input type="checkbox"/>	<input type="checkbox"/>	Mental disorders of any sort: depression, anxiety, etc.	<input type="checkbox"/>	<input type="checkbox"/>	Military medical discharge
<input type="checkbox"/>	<input type="checkbox"/>	Dizziness or fainting spell	<input type="checkbox"/>	<input type="checkbox"/>	High or low blood pressure	<input type="checkbox"/>	<input type="checkbox"/>	Substance dependence or failed a drug test ever, or substance abuse or use of illegal substance in the last 2 years.	<input type="checkbox"/>	<input type="checkbox"/>	Medical rejection by military service
<input type="checkbox"/>	<input type="checkbox"/>	Unconsciousness for any reason	<input type="checkbox"/>	<input type="checkbox"/>	Stomach, liver, or intestinal trouble	<input type="checkbox"/>	<input type="checkbox"/>	Alcohol dependence or abuse	<input type="checkbox"/>	<input type="checkbox"/>	Admission to hospital
<input type="checkbox"/>	<input type="checkbox"/>	Eye or vision trouble except glasses	<input type="checkbox"/>	<input type="checkbox"/>	Kidney stone or blood in urine	<input type="checkbox"/>	<input type="checkbox"/>	Suicide attempt	<input type="checkbox"/>	<input type="checkbox"/>	Other illness, disability, or surgery
<input type="checkbox"/>	<input type="checkbox"/>	Hay fever or allergy	<input type="checkbox"/>	<input type="checkbox"/>	Diabetes	<input type="checkbox"/>	<input type="checkbox"/>	Motion sickness requiring medication	<input type="checkbox"/>	<input type="checkbox"/>	Medical disability benefits
<input type="checkbox"/>	<input type="checkbox"/>	Asthma or lung disease	<input type="checkbox"/>	<input type="checkbox"/>	Neurological disorders: epilepsy, seizures, stroke, paralysis, etc.						

Arrest, Conviction, and/or Administrative Action History — See Instructions Page

Yes **No** History of (1) any arrest(s) and/or conviction(s) involving driving while intoxicated by, while impaired by, or while under the influence of alcohol or a drug; or (2) history of any arrest(s), and/or conviction(s), and/or administrative action(s) involving an offense(s) which resulted in the denial, suspension, cancellation, or revocation of driving privileges or which resulted in attendance at an educational or a rehabilitation program.

Yes **No** History of nontraffic conviction(s) (misdemeanors or felonies).

Explanations: See Instructions Page

FOR FAA USE
Review Action Codes

19. Visits to Health Professional Within Last 3 Years. Yes (Explain Below) No **See Instructions Page**

Date	Name, Address, and Type of Health Professional Consulted	Reason

20. Applicant's National Driver Register and Certifying Declarations

Whoever in any matter within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals or covers up by any trick, scheme, or device a material fact, or who makes any false, fictitious or fraudulent statements or representations, or entry, may be fined up to \$250,000 or imprisoned not more than 5 years, or both, (18 U.S. Code Secs. 1001; 3571).

I hereby authorize the National Driver Register (NDR), through a designated State Department of Motor Vehicles, to furnish to the FAA information pertaining to my driving record. This consent constitutes authorization for a single access to the information contained in the NDR to verify information provided in this application. Upon my request, the FAA shall make the information received from the NDR, if any, available for my review and written consent. Authority: 23 U.S. Code 401, Note.

NOTE: ALL persons using this form must sign it. NDR consent, however, does not apply unless this form is used as an application for Medical Certificate or Medical Certificate and Student Pilot Certificate.

I hereby certify that all statements and answers provided by me on this application form are complete and true to the best of my knowledge, and I agree that they are to be considered part of the basis for issuance of any FAA certificate to me. I have also read and understand the Privacy Act statement that accompanies this form.

Signature of Applicant _____ Date M M / D D / Y Y Y Y

FAA Form 8500-8 (9-08) Supersedes Previous Edition NSN: 0052-00-670-6002

1.10a Example of the FAA Form 8500-8 Medical Examination, Page 1

cally by the AME to the FAA. The Civil Air Patrol would like to thank the FAA for making this and many other pilot safety and aeromedical publications available to the aviation community.

Details of the FAA’s standard for being an airworthy pilot

So that everyone fully understands what the FAA considers the standards of being fit for flying, Dr. Sancetta will give in-depth de-

NOTE: FAA/Original Copy of the Report of Medical Examination Must be TYPED.

REPORT OF MEDICAL EXAMINATION													
21. Height (inches)		22. Weight (pounds)		23. Statement of Demonstrated Ability (SODA) <input type="checkbox"/> YES <input type="checkbox"/> NO Defect Noted:				24. SODA Serial Number					
CHECK EACH ITEM IN APPROPRIATE COLUMN						CHECK EACH ITEM IN APPROPRIATE COLUMN							
Normal						Abnormal							
25. Head, face, neck, and scalp						37. Vascular system (Pulse, amplitude and character, arms, legs, others)							
26. Nose						38. Abdomen and viscera (including hernia)							
27. Sinuses						39. Anus (Not including digital examination)							
28. Mouth and throat						40. Skin							
29. Ears, general (Internal and external canals; Hearing under item 49)						41. G-U system (Not including pelvic examination)							
30. Ear Drums (Perforation)						42. Upper and lower extremities (Strength and range of motion)							
31. Eyes, general (Vision under items 50 to 54)						43. Spine, other musculoskeletal							
32. Ophthalmoscopic						44. Identifying body marks, scars, tattoos (Size & location)							
33. Pupils (Equity and reaction)						45. Lymphatics							
34. Ocular motility (Associated parallel movement, nystagmus)						46. Neurologic (Tendon reflexes, equilibrium, senses, cranial nerves, coordination, etc.)							
35. Lungs and chest (Not including breast examination)						47. Psychiatric (Appearance, behavior, mood, communication, and memory)							
36. Heart (Precordial activity, rhythm, sounds, and murmurs)						48. General systemic							
NOTES: Describe every abnormality in detail. Enter applicable item number before each comment. Use additional sheets if necessary and attach to this form.													
49. Hearing		Record Audiometric Speech Discrimination Score Below		Right Ear				Left Ear					
Conversational Voice Test at 6 Feet <input type="checkbox"/> Pass <input type="checkbox"/> Fail		Audiometer Threshold in decibels		500	1000	2000	3000	4000	500	1000	2000	3000	4000
50. Distant Vision			51.a. Near Vision			51.b. Intermediate Vision - 32 inches			52. Color Vision				
Right 20/	Corrected to 20/	Left 20/	Corrected to 20/	Right 20/	Corrected to 20/	Left 20/	Corrected to 20/	Right 20/	Corrected to 20/	Left 20/	Corrected to 20/	<input type="checkbox"/> Pass <input type="checkbox"/> Fail	
Both 20/	Corrected to 20/	Both 20/	Corrected to 20/	Both 20/	Corrected to 20/	Both 20/	Corrected to 20/	Both 20/	Corrected to 20/	Both 20/	Corrected to 20/		
53. Field of Vision <input type="checkbox"/> Normal <input type="checkbox"/> Abnormal		54. Heterophoria 20' (in prism diopters)		Esophoria		Exophoria		Right Hyperphoria		Left Hyperphoria			
55. Blood Pressure (Sitting, mm of Mercury)		56. Pulse (Resting)		57. Urine Test (If abnormal, give results)				Albumin		Sugar		58. ECG (Date) M M D D Y Y Y Y	
				<input type="checkbox"/> Normal <input type="checkbox"/> Abnormal									
59. Other Tests Given													
60. Comments on History and Findings: AME shall comment on all "YES" answers in the Medical History section and for abnormal findings of the examination. (Attach all consultation reports, ECGs, X-rays, etc. to this report before mailing.)										FOR FAA USE			
										Pathology Codes:			
										Coded By:			
										Clerical Reject			
Significant Medical History <input type="checkbox"/> YES <input type="checkbox"/> NO						Abnormal Physical Findings <input type="checkbox"/> YES <input type="checkbox"/> NO							
61. Applicant's Name				62. Has Been Issued — <input type="checkbox"/> Medical Certificate <input type="checkbox"/> Medical & Student Pilot Certificate <input type="checkbox"/> No Certificate Issued — Deferred for Further Evaluation <input type="checkbox"/> Has Been Denied — Letter of Denial Issued (Copy Attached)									
63. Disqualifying Defects (List by item number)													
64. Medical Examiner's Declaration — I hereby certify that I have personally reviewed the medical history and personally examined the applicant named on this medical examination report. This report with any attachment embodies my findings completely and correctly.													
Date of Examination		Aviation Medical Examiner's Name				Aviation Medical Examiner's Signature							
M M D D Y Y Y Y		Street Address				AME Serial Number							
		City		State		Zip Code		AME Telephone ()					

FAA Form 8500-8 (9-06) Supersedes Previous Edition NSN: 0052-00-670-6002

1.10b The FAA Form 8500-8 Medical Examination, Page 2

tails covering the pilot's personal history section on Page One of the 8500-8.

For those interested in what the Aviation Medical Examiner will test for, an online search at www.faa.gov will be useful. Look for the Guide for Aviation Medical Examiners Decision Considerations where 57 detailed explanations are found under Aerospace Medical Dispositions.



1.11 CAP Cadet Hannah Schuele received her Third Class Medical examination in preparation for a summer flight encampment in the Colorado Wing. Dr. Sancetta was her Aviation Medical Examiner. (Photo courtesy of Hanna Schuele)

A synopsis of the FAA medical standards

Medical Certificate Pilot Type	First-Class Airline Transport Pilot	Second-Class Commercial Pilot	Third-Class Private Pilot
<u>Distant Vision</u>	20/20 or better in each eye separately, with or without correction, using the standard Snellen Eye Chart (or other FAA approved vision testing devices).		20/40 or better in each eye separately, with or without correction
<u>Near Vision</u>	20/40 or better in each eye separately, with or without correction, as measured at 16 inches		20/40 or better in each eye separately, with or without correction
<u>Intermediate Vision</u>	20/40 or better in each eye separately, with or without correction at age 50 and over, as measured at 32 inches		No requirement
<u>Color Vision</u>	Ability to perceive those colors necessary for safe performance of airman duties		

Medical Certificate Pilot Type	First-Class Airline Transport Pilot	Second-Class Commercial Pilot	Third-Class Private Pilot
<u>Hearing</u>	Demonstrate hearing of an average conversational voice in a quiet room, using both ears at 6 feet, with the back turned to the examiner or pass one of the audiometric tests below		
<u>Audiology</u> (required only if the applicant fails the basic hearing test)	Audiometric speech discrimination test: score at least 70% reception in one ear Pure tone audiometric test: Unaided, with thresholds no worse than:		
	500 Hz	1000 Hz	2000 Hz 3000 Hz
<u>Better Ear</u>	35 dB	30 dB	30 dB 40 dB
<u>Worst Ear</u>	35 dB	50 dB	50 dB 60 dB
<u>Ear, Nose, Throat</u>	No ear disease or condition manifested by, or that may reasonably be expected to be maintained by, vertigo or a disturbance of speech or equilibrium		
<u>Pulse</u>	Not disqualifying per se; used to determine cardiac system status and responsiveness (must explain if less than 50 or greater than 100).		
<u>Blood Pressure</u>	No specified values stated in the standards. The current guideline maximum value is 155/95		
<u>Electrocardiogram (ECG)</u>	At age 35 and annually after age 40 (first-class only)		Not routinely required. (second- and third-class)
<u>Mental</u>	No diagnosis of psychosis, or bipolar disorder, or severe personality disorders		
<u>Substance Dependence and Substance Abuse</u>	A diagnosis or medical history of substance dependence is disqualifying unless there is established clinical evidence, satisfactory to the Federal Air Surgeon, of recovery, including sustained total abstinence from the substance(s) for not less than the preceding 2 years. A history of substance abuse within the preceding 2 years is disqualifying. Substances include alcohol and other drugs (i.e., PCP,		

sedatives and hypnotics, anxiolytics, marijuana, cocaine, opioids, amphetamines, hallucinogens, and other psychoactive drugs or chemicals).

Disqualifying Conditions

Unless otherwise directed by the FAA, the examiner must deny or defer if the applicant has a history of: (1) diabetes mellitus requiring hypoglycemic medication; (2) angina pectoris; (3) coronary heart disease that has been treated or, if untreated, that has been symptomatic or clinically significant; (4) myocardial infarction; (5) cardiac valve replacement; (6) permanent cardiac pacemaker; (7) heart replacement; (8) psychosis; (9) bipolar disorder; (10) personality disorder that is severe enough to have repeatedly manifested itself by overt acts; (11) substance dependence; (12) substance abuse; (13) epilepsy; (14) disturbance of consciousness and without satisfactory explanation of cause, and (15) transient loss of control of nervous system function(s) without satisfactory explanation of cause.

Dr. Sancetta's discussion of his professional philosophy concerning the FAA medical examination and its impact upon a pilot's career

“Many pilots have a great deal of apprehension about the FAA medical examination; and some go so far as to withhold information in fear of being grounded. Others withhold the truth because they ‘don’t want to open another can of worms.’ Pilots realize that the AME is going to have to make a ‘judgment call,’ or a subjective decision, on one or more of the parameters of the *8500-8*. This can be a concern for both the physician and the pilot. Most AME doctors go to great lengths to be fair and supportive of their pilot applicants.

First of all, I feel that pilots should be very honest with themselves and the FAA about their own personal medical conditions. I tell my pilots that as long as they are alive, I can usually help them. In the vast majority of cases where pilots are grounded and lose their medical certificate, I can usually help them get it back.

My goal is not to just be a pilot medical examiner but also to help the pilots with ‘health maintenance.’ I don’t want to just hand pilots a medical certificate; moreover, I would like to think that I am handing them the next 20 medical certificates, because I want to make them

aware of how to stay healthy so that they will have a long and successful flying experience. While the purpose of the FAA medical exam is not truly to be a health maintenance exam, those of us who are dedicated to our pilots are, in fact, interested in their long-term health.

(REDLINE) The FAA’s goal is to predict, as best they can, the concept of a pilot’s risk for sudden incapacitation in the cockpit. Their mandate is to only do that for the duration of the certificate. In other words, they’re not trying to make any long term prediction as to the health of the pilot. It’s not their charge; however, along the same philosophy that I have, the Federal Air Surgeon, Fred Tilton, MD, discusses in an issue of the *Federal Air Surgeon’s Bulletin* how the AME can interact with the pilots as a service. The FAA really does want us to promote health maintenance.

Many times in conference presentations when the audience gets an opportunity to participate in a ‘Q&A,’ the question is asked, ‘Does the pilot have to be in the same physical condition throughout the duration of the medical certificate to be legal to fly?’ **(RED-LINE) Theoretically, it’s the pilot’s responsibility to determine whether or not they are safe to fly. If there have been significant health changes within the duration of the medical certificate, it’s up to the pilot to determine whether or not an issue threatens the pilot’s safe performance.** The process by which this determination has to be made is covered under Federal Air Regulation (FAR) 61.53. The FAA considers this so important that reference to it is printed on the flip-side of every certificate. It basically says that if a pre-existing condition worsens, *or*; if a new condition develops, *or* a new medication is in use that significantly affects the safe performance of a pilot; then it is the pilot’s responsibility to get appropriate treatment to take care of the problem before continuing to exercise the privileges of the issued certificates.

FAR § 61.53 Prohibition on operations during medical deficiency

(a) Operations that require a medical certificate. Except as provided for in paragraph (b) of this section, a person who holds a current medical certificate issued under part 67 of this chapter shall not act as pilot in command, or in any other capacity as a required pilot flight crew member, while that person:

(1) Knows or has reason to know of any medical condition that would make the person unable to meet the requirements for the medical certificate necessary for the pilot operation, or

(2) Is taking medication or receiving other treatment for a medical condition that results in the person being unable to meet the requirements for the medical certificate necessary for the pilot operation.

(b) Operations that do not require a medical certificate. For operations provided for in §61.23(b) of this part, a person shall not act as pilot in command, or in any other capacity as a required pilot flight crewmember, while that person knows or has reason to know, of any medical condition that would make the person unable to operate the aircraft in a safe manner.

Obviously for something simple like having the flu, once the pilot is feeling back to normal they can resume flight status without any formal approval from the FAA. On the other hand, for example, if a kidney stone has passed or if the pilot has developed heart disease, then it's the pilot's responsibility to bring this to the attention of their AME for advice on how to best seek medical reinstatement with the FAA. When it comes down to issues that would immediately ground a pilot, the FAA clearly states 15 of these in the FARs (found on page 16). Now, there are mechanisms through the Special Issuance program to ultimately get many of these pilots flying again.



*1.12 Because of her age and outstanding health, Dr. Sancetta was actually able to give Hannah a First-Class Medical Certificate that has a duration of 5 years.
(See pages 20-21 for discussion of certificate validity periods.)*

Ultimately FAR 61.53 (**REDLINE**) places the responsibility directly on the pilot to determine whether or not he/she is safe to fly. How does the pilot go about doing this? The pilot has to use his/her own judgment; and then possibly:

- seek counsel from a reputable AME whom they trust;
- contact the Aircraft Owners and Pilots Association (AOPA); which has an excellent medical department;
- contact his/her airline's consulting medical doctors; or
- contact the FAA directly.

In many interactions with pilots, whether it is in seminars or roundtable discussions, the question often surfaces, 'Why do we have all of these medical standards? We aren't required to have a medical examination to operate a car.' The answer is *safety*. It's safety for the pilot, the passengers, and people on the ground. This also includes property on the ground or other aircraft in the air. It is also a publicity issue. Any time there is a significant aircraft crash, of course, it's national news. It wouldn't look good if airplanes crashed due to untreated medical problems with the pilots. We don't expect all pilots to be Olympic marathon runners; however, we do want them to be healthy, stable, and safe enough that they are at low risk to experience 'sudden incapacitation' while in flight during the duration of their medical certificate.

Another question that often comes up with pilots is, 'Just how often does an accident occur because a pilot has a medical problem?' The answer is 'very infrequently.' Well, of course, this generates the response, 'Why, then, do we need all of these medical restrictions and regulations?' The answer is that pilots are forced to take care of conditions that they might not take care of otherwise to maintain their special issuance authorization. This is one of the reasons why there are very few crashes due to medical conditions. Another reason is that it reinforces what we were saying about a healthy lifestyle. If a pilot takes better care of personal fitness, they will live longer and have a safe flying experience.

We have now determined that there are rules. These rules are based on the Code of Federal Regulations (CFR) Part 67, which outlines the basic medical standards. The FAA also has the mandate to rule on any issue that they feel requires their decision, and this includes all of the 15 disqualifying conditions listed.

Pilots will ask, 'If I pass my FAA exam, will it then be necessary to see my regular primary care physician?' The answer is 'yes.' One must remember that the items on the FAA exam are tailored to performance skills related to flying an airplane. This does not mean that

pilots should not see a primary care physician who will help them with their complete total health maintenance.

Regarding the medical classes, a First-Class Certificate is required for all pilots operating an aircraft as pilot in command under FAR Part 121 and some Part 135 operations. This includes all airline captains (and also the co-pilots in certain international operations). Some charter operations are also included in this requirement. These are very often performed using aircraft that have performance capabilities equal to those of scheduled airliners. One example is an aircraft that I've flown known as the Gulfstream IV. These airplanes are quite capable of international operations and the pilots are often required to have and maintain a First-Class Medical Certificate.



*1.13 The flight crews of the elegant Gulfstream IV are sometimes required to have a First-Class Medical Certificate, much the same as airline pilots operating under FAR Part 121.
(Image by Adam Wright)*

Under a change in rules adopted in 2008, the First-Class Medical Certificate has a duration of one year if the pilot is under age 40 at the time of issuance. At age 40, things change. For a pilot in command of operations which require a First-Class Medical Certificate, after age 40 the duration becomes every 6 months. One must remember that for operations where only a Private Pilot Certificate is required; the pilot can get a First-Class Medical Certificate and it will be valid for as much as 5 years if the individual is under 40 years old, and 2 years for pilots age 40 or older at the time of issuance.

The Second-Class Medical Certificate is good for one year regardless of age. It is often used for non-pilot-in-command in Part 121

operations. An example would be co-pilots for an airline which primarily flies domestically. If a person flies a high performance aircraft like the Gulfstream, many insurance companies are going to require that the pilot has a First-Class Medical Certificate, even if the FARs don't (for the typical operations of that aircraft). The Second-Class Medical Certificate is used most typically for commercial operations, such as crop dusting, towing gliders, and, as noted, some charter and airline operations. In reality, Dr. Sancetta states that he issues many more First-Class Medical Certificates than Second-Class. This provides the pilot with many more potential flight operation options.

The Third-Class Medical Certificate is primarily used for noncommercial, private privileges. Under age 40, the duration is now 5 years. For those 40 or older, it is valid for 2 years.

An interpretation that the FAA came out with in the 1990s was that a flight instructor can actually teach, as pilot-in-command (PIC), for compensation, with only a Third-Class Medical Certificate. This allows some pilots with a medical condition that limits them to a Third-Class to continue instructing. The 'Student Pilot Certificate' is valid for a maximum of 2 years, regardless of any theoretical duration of the accompanying medical certificate.

Interestingly, when a pilot receiving instruction can actually be considered to be the pilot-in-command, the flight instructor would not even have to have a medical certificate to be flying. For example, let's say a pilot owns his own Bonanza airplane and needs recurrent training to get his (biennial) flight review. In this case, the owner is the pilot-in-command and the flight instructor can go with him and be legal to instruct even without a medical certificate.

If the question came up, 'How old do you have to be to get a medical certificate?' The answer would be that there is no age requirement to get a medical certificate. There is, however, a minimum age requirement to get a Student Pilot Certificate, and that, of course, is 16. Since a pilot may want to solo on their 16th birthday, he/she may actually go in during the month prior to that date and get a medical certificate with the restriction that it is not valid until the actual birth date.

To get a medical certificate, the pilot's first interaction with the FAA is Form 8500-8, a standard three-part government form that a pilot fills out at the AME's office. Just recently, the FAA has introduced a new system wherein a pilot can fill out the 8500-8 online called the MedXpress system. The FAA MedXpress system allows anyone requiring FAA medical certificate or Airman Medical and Student Pilot Medical Certificate to electronically complete the FAA Form 8500-8. Information entered into MedXpress will be transmit-

ted to the FAA and will be available for the AME to review at the time of the medical examination.”

REDLINE: Since many Civil Air Patrol cadets plan on becoming professional pilots someday, this should give them a good idea of how important it is to maintain good health throughout their life. They must understand that drugs and alcohol can destroy a career. Fitness and good health are critical to a long and successful flying career.

The importance of an applicant’s medical history

Dr. Sancetta continues his discussion on explaining the importance of an applicant’s medical history. “It is important that an applicant for a medical certificate answer each section of the application honestly. Knowing all health-related issues and associated medications used will enable the AME to accurately determine the airworthiness of the applicant. A thorough explanation of each section of the medical history application follows.

1. **Application For** – As a student pilot, the selection would be “Airman Medical and Student Pilot Certificate.”

2. **Class Of Medical Certificate Applied For**

3. **Last name First Name Middle Name**

4. **Social Security Number** – NO LONGER IS REQUIRED.

We can now generate pseudo-social security numbers. I recommend this when a student pilot enters the FAA ‘system.’ In that way, the actual SSN will never be in the system. The pilot can also request that the SSN is not printed on the certificate. Typically the pseudo-numbers used for the medical and pilot certificates will be different.

5. **Address Telephone Number**

6. **Number/Street**

7. **Date Of Birth**

8. **Color Of Hair**

9. **Color Of Eyes**

10. **Sex**

11. **Type Of Airman Certificate You Hold**

12. **Occupation Employer**

13. **Any Denied, Suspended, Or Revocation Of Your FAA**

Airman Medical Certificate – It is recommended that any pilot candidate be completely honest on this question. The FAA system is supposed to automatically display this information to the AME when entering an exam. This doesn’t always work, however, so honesty is important. A prior denial might

have an impact as to whether the AME can issue a new certificate at the time of the exam.

14. **Total Pilot Time (Civilian Only)** – The question has come up, ‘Why does the FAA have to know this?’ The answer is that this is the most frequent way that the FAA has to make contact with every pilot in the system. The FAA uses this information primarily for demographic research.

17. **Current Use Of Any Medication: Prescription Or Non-prescription** – The most important medications that the FAA wants to know about are those which might have an effect on the safety and performance of a pilot. One very important example of why it is necessary to disclose medications is the use of blood pressure medications known as ‘beta blockers.’ Beta blockers are approved for use by the FAA for blood pressure elevation. On the other hand, beta blockers are also used for the control of intractable migraine headaches and panic attacks, and those medical conditions are more of a concern than the medication itself. For reasons, such as this, the pilot should let the FAA know precisely which medications are being taken, and for what reasons.

The pilot may ask, ‘Why are nonprescription medications of any concern to the FAA?’ There are many OTCs (over-the-counter medications) that can impact aviation safety. Some may cause drowsiness, such as antihistamines used for allergies. In fact, antihistamines are also used in OTC sleep medications because of its drowsiness side effect.

17b. **Use Near Vision Contact Lenses While Flying** – Yes
 No

18. **Medical History – Any Life Diagnosis Either Past Or Present Of The Following** –

Frequent Or Severe Headaches – The FAA’s greatest concern is for people who have a history of intractable migraine headaches; headaches that are severe enough to require narcotic medications to alleviate them, especially if they are frequent. These are likely to be disqualifying; however, there are pilots with infrequent and non-incapacitating migraines who do qualify for a medical certificate. Obviously, minor tension headaches that are not incapacitating will not be disqualifying.

Dizziness Or Fainting Spells – Syncopal episodes need to be carefully evaluated. A history of fainting during a blood draw or when dehydrated after a protracted illness will not be disqualifying. These are not likely to recur when flying, so they aren’t a problem for FAA medical certification; however, repet-

itive fainting episodes, especially if they have some neurological or cardiovascular cause, might very well be disqualifying. If there is a risk of a recurrent fainting episode in flight, the pilot won't qualify for a medical certificate.

- **Unconsciousness For Any Reason** – When reviewing a history of unconsciousness, the FAA is concerned about whether there is a chance of recurrence and/or whether or not the cause of the unconsciousness itself has led to brain damage that might impact safety. For example, a minor concussion when playing sports many years ago (if there were no long-term problems thereafter) is not likely to disqualify a pilot; however, if the unconsciousness was due to a recent high speed accident (such as on a mountain bike or snowboarding fall); and there was a significant brain injury that may have included intracranial (inside the skull) bleeding, then that pilot may be disqualified for two years or more. The FAA must assess for the risk of post-traumatic seizures which are possible when the brain is healing from such an event. Additionally, if there have been any cognitive (basic thought processes) deficits from the accident, those must be resolved completely before the pilot can regain a medical certificate.
- **Eye Or Vision Trouble, Except Glasses** – This doesn't apply to routine eye exams for screening purposes or to update a prescription change. This section mainly applies for eye pathology, such as cataracts, retinal detachment, monocularly, or significant visual field deficits due to trauma or illness. Fortunately, most eye pathology that is well treated and stable will not disqualify a pilot. Even pilots who have vision in only one eye can obtain a medical certificate (via the waiver process). For any potentially progressive eye problems, formal evaluations, and sometimes visual field assessments, must be periodically provided to the FAA. Obviously, at least one eye must meet the vision standards for a pilot to obtain a medical certificate.
- **Hay Fever Or Allergy** – People who have severe allergies are also at risk for possible sinus blockages. This could be a possible incapacitating issue. Pilots are asked whether or not they are taking allergy medications, and, of course, the concern is whether or not this medication can cause drowsiness. If so, this is a safety issue. There are several allergy medications approved for pilots including some desensitization shots.

Mild seasonal allergies are not disqualifying. Severe allergies, however, can cause significant symptoms that might affect flight safety. This includes excessive tearing, which can

cause blurred vision, and possibly even sinus blockages, which can be truly incapacitating. Some allergy medications can cause drowsiness. Fortunately, there are several allergy medications approved for use by pilots, as they typically do not cause drowsiness or other concerning side effects.

- **Asthma Or Lung Disease** – Asthma that is mild is usually approvable. There are pilots flying who require asthma medications, including inhalers. We are concerned about pilots who have frequent exacerbations with their asthma that may cause them to have severe breathing difficulties and possibly end up in the emergency room. Note: ‘Exacerbation’ means a worsening of the symptoms or asthma conditions. It could be what is called a ‘flare up.’ (This applies in the discussion of any illness.) Chronic lung disease can sometimes decrease function to where a pilot is at risk for hypoxia at altitude. Fortunately, pilots with mild lung disease or asthma, when they are determined to be of minimal risk when flying, can get certified.
- **Heart Or Vascular Trouble** – The most obvious conditions here are heart attack, bypass surgery, stent placement, and valve replacement. Those clearly need to be evaluated and must be looked at with long-term follow-up. There have been pilots who have actually had a heart attack while flying an airplane and they were lucky enough to live through it and get the airplane down safely. The wonderful thing about the special issuance program is that after a life-threatening incident, it forces pilots to completely change their health maintenance lifestyle to get back flying again. They quit smoking; they exercise like fiends; they limit their alcohol intake; they lose weight; and they make a serious effort to lower the risk of another event. In the majority of cases, they are some of our safest pilots. You would imagine that the FAA could just say, ‘You’re out the door;’ however, aircraft accident statistics have shown that older, more experienced pilots are typically safer pilots. It is actually in the FAA’s best interest to keep these individuals flying. If they have had successful treatment and the prediction that is these individuals have substantially lowered the risk of another event, then we do everything we can to get them flying again.
- **High Or Low Blood Pressure** – Low blood pressure is usually not a major concern; however, consistently high blood pressure raises the risk of a stroke, heart attack, and kidney disease. If the pilot can be put on an approved treatment medication, it not only lowers the risk for stroke (or other complications) but also lowers the risk for many years down the road.

- **Stomach, Liver, Or Intestinal Trouble** – One of the greatest concerns is stomach ulcers. Ulcers can bleed, and the loss of blood puts the pilot at a higher risk for hypoxia. With intestinal issues, the greatest concern is cancer, especially colon cancer. Other conditions of concern include hepatitis and the various versions of inflammatory bowel disease. Once again, when almost any of these conditions have stabilized, the pilot can get recertified.
- **Kidney Stone Or Blood In Urine** – A kidney stone can be quite incapacitating. I have one airline pilot whose kidney stone hit just after he landed the airplane. He could not taxi the aircraft to the gate due to excruciating pain. They had to shut it down on the ramp and get the paramedics to take him off the airplane. Kidney stones can be truly incapacitating. However, if the stone(s) have cleared, and there are no residual (potentially incapacitating) stones, and any metabolic contribution has been corrected, as well, then pilots can resume flying via the special issuance process.
- **Diabetes** – This diagnosis is number one on the list of the 15 FAR Part 67 disqualifiers. Diabetes is a problem with the metabolism of blood sugar. The blood sugar gets way too high, either because of decreased production of the hormone insulin or the inability of the body to utilize it. Diabetes has been called ‘starvation in the midst of plenty.’ What happens is the blood sugar is high, but the body’s organs and tissues can’t use all of it for the energy needs of the body. In the long run, it causes problems with the heart, eyes, and kidneys. In the short term, the blood sugar can get so high that the person can pass out. If the person is taking medication, such as insulin injections, and the blood sugar gets too low, the person can pass out, also. Typically, diabetic pilots are very motivated to maintain their diet, to exercise, and to live a healthy lifestyle. A well-controlled diabetic has a minimal risk of incapacitation in flight. Therefore, the Special Issuance Program has been very successful for pilots with diabetes.
- **Neurological Disorders: Epilepsy, Seizures, Stroke, Paralysis, Etc.** – People who have seizure disorders (or seizures controlled with medications) usually won’t qualify for a medical certificate. This doesn’t mean that people who have had a seizure sometime in the distant past won’t ever fly. There are some instances where a young child has had an illness with a very high fever and a subsequent seizure (febrile seizure). Usually this does not create an issue as they become adults. Basi-

cally, pilots who have had a seizure (or even childhood epilepsy) a long time ago, without recurrence, have a good chance of getting their medical certificate if it can be determined that they are likely at low risk for a new event. An adult who still has a seizure disorder (regardless of whether it can be controlled with anti-seizure medication) will not get a medical certificate. Pilots who have had strokes, have recovered well, and have had their risk factors corrected stand a good chance of obtaining a medical certificate.

- **Mental Disorders Of Any Sort, Depression, Anxiety, Etc.** – Depression that is ‘situational’ (such as after a divorce or death in the family) and has been resolved, usually does not prevent a pilot from getting a medical certificate. Even if treatment with antidepressant medication was required, if the pilot is doing well and off medications for at least 90 days, then he/she can get the medical reinstated. What about pilots still taking antidepressant medications? In April 2010 the FAA issued a policy to permit some pilots to fly while taking antidepressant medications. Previously, no use of antidepressant medications while flying was permitted, regardless of the reason why the pilot was taking them (antidepressant medications can be used for a host of medical conditions beyond simply depression).

Without belaboring the specifics of the actual protocol, this policy permits pilots taking a single antidepressant medication for mild to moderate depression to apply for a medical certificate. The pilot will have to be stable (both in regard to any medication side effects and the depressive illness itself) for a period of time, and will have to undergo extensive formal psychiatric and neuropsychological evaluations prior to approval. Once approved, periodic retesting and additional evaluations will also be required.

While this policy is in its infancy at this time, it is hoped that eventually (if we can demonstrate continued safety of flight in this pilot population) it will be amended to include more antidepressant medication options and possibly become accessible for more pilots than will qualify based on the initial protocol. This will certainly be a work in progress for the foreseeable future.

That said, please also understand that for safety reasons the FAA is currently not planning to approve any pilot who needs multiple antidepressant medications. Further there are no plans to include approval for other psychiatric conditions that are clearly an obvious threat to the safety of flight, regardless of how stable that condition appears under medical therapy. Such

conditions include any history of psychosis, mania, or significant personality disorders.

Probably the biggest controversial condition is a history of Attention Deficit Hyperactivity Disorder (ADHD). In my many years as an AME, the FAA internal policies on how to deal with this condition have been in a continuous flux. (No ADHD medications are approved in pilots.) Clearly, a pilot with significant ADHD shouldn't be flying, as important task management strategies might be compromised during the stress of an emergency. A child who had mild ADHD in school and is now doing well and is off medications as a young adult, 'might' (emphasis on 'might,' as the FAA seems to go back and forth on this situation) eventually qualify for a medical certificate. The initial psychiatric and psychological testing to determine this is expensive and time-consuming, with no guarantees being stated as to the FAA's policy on this in the future.

Substance Dependence Or Failed A Drug Test Ever; Or Substance Abuse Or Use Of Illegal Substance In The Last 2 Years – In view of the message that this book is trying to convey, it is highly recommended that drugs and alcohol be avoided from the very beginning. The FAA has a successful program to get pilots back flying after a period of drug abuse and rehabilitation. The majority of these pilots are highly motivated and many return to a successful career of flying.

Alcohol Dependence Or Abuse – This is one of the most serious problems that pilots face. While it has been stated above that there is a very successful program to get alcoholic pilots back into the cockpit; it can't be overstated what a tremendously expensive and emotionally difficult challenge this is for the pilot. (The details of the program are beyond the scope of this book, as it is hoped that this problem will be avoided in the first place.) Alcoholism is one of the most difficult problems facing society as a whole, causing all kinds of medical problems for the pilot, as well as personal and family problems. Once again, the advice is to simply avoid alcohol and drugs. Now, I am not naive and I do realize that some future pilots will ultimately use alcohol on a social basis; however, who wants to take the risk that he or she is the one who will wind up with a problem which not only interferes with the potential career as a pilot but also impacts their entire lives?

(REDLINE) A word to the wise—everyone can survive without alcohol or drugs, but they may not survive *with* them.



*1.14 Another corporate jet in Dr. Sancetta's logbook is the Hawker 800.
(Image is by Adam Wright)*

- Suicide Attempt** – This goes along with depression and anxiety. We do have pilots who did attempt suicide in the distant past, but as long as the emotional problems are resolved to the point where the pilot is no longer at risk to make another attempt, then that pilot can regain FAA medical certification. Clearly, any psychiatric problem that is currently severe enough to cause the pilot to consider suicide precludes an FAA medical certification.
- Motion Sickness Requiring Medication** – Many pilots have experienced some form of motion sickness, especially early in their training. The medications for motion sickness usually cause drowsiness and should not be taken when the person is acting as pilot-in-command. Fortunately, most pilots eventually get over any motion sickness problems. The point is, if you have gotten to the point where you no longer have motion sickness events as a pilot-in-command, you can get a medical certificate.
- Military Medical Discharge** – If this is an issue, it has to be evaluated on an individual basis. The FAA is simply asking this to help uncover any other medical conditions that may have otherwise been overlooked or forgotten.
- Medical Rejection By Military Service** – If the condition has stabilized or has been resolved and the FAA is satisfied that the pilot is safe, then he/she stands a good chance of getting a medical certificate as a civilian candidate.
- Rejection For Health Insurance** – Same as above.
- Admission To Hospital** – This is designed to address issues that are not included in the other history items of the individual already noted on the 8500-8 form.

- History Of Non-Traffic Conviction(s) (Misdemeanors Or Felonies)**
- Other Illness, Disability, Or Surgery** – Once again, this is to amplify on items that might not have been specifically asked and answered elsewhere on the 8500-8 form. Simple orthopedic, appendix, and hernia surgeries are not disqualifying. (Usually pilots may resume flying as soon as their physician releases them back to normal activities.) Other conditions, such as thyroid disorders, should be reported here. They are typically approved when stable.
- Medical Disability Benefits** – While this question will not typically impact a young pilot, the FAA recently added it to the 8500-8 form. Please understand that the FAA has no problem with professional pilots who appropriately received disability payments while grounded and awaiting a special issuance authorization (for their recently treated heart disease or diabetes, for example). This question is a result of a research study done by the FAA. They found many pilots who were receiving significant disability payments from government organizations (for example, after injury or illness suffered during military duties) were also holding First Class Medical Certificates. In obtaining the FAA medical certificate, they were not disclosing the medical condition(s) that were claimed for the disability payments. So, were they being untruthful in obtaining the disability payments, or, to the FAA in obtaining their medical certificates? These were classic cases of fraudulent ‘double dipping,’ so to speak.”

An honor system and the doctor’s final thoughts

Dr. Sancetta offers closing thoughts on being an honest and ethical pilot candidate. “Whether it’s in the AME’s office or using the new MedXPress online, it is the honor system that leads to safe pilots. The FAA doesn’t want to play ‘detective,’ nor does it have the resources to play ‘detective.’ The FAA depends upon the pilots to provide honest information about their medical history. In the vast majority of medical conditions that we have discussed here, if they are properly treated, the pilot can obtain a medical certificate.

The next question is very important because it asks about arrests and/or convictions involving drug or alcohol. By signing this form, it allows the FAA to access the National Driver Register, and they *will* check the NDR on every pilot. To lie on this question is a serious issue with the FAA. Whether it is a driving under the influence (DUI) or driving while ability impaired (DWAI), it needs to be re-

ported to the Security Division of the FAA within 60 days of that action. Therefore, this action not only has to be reported on the 8500-8, it must be reported to the Security Division of the FAA. In the past, a single DUI did not complicate the issuance of a medical certificate (as long as the AME was comfortable there was no ongoing alcohol abuse). Late in 2009, however, this situation changed dramatically. The reporting and documentation required after even a single/first DUI is now often quite extensive (especially in cases where the blood alcohol concentration was high at the time of arrest). In such cases, the pilot may very well be required to obtain a formal Substance Abuse Evaluation, which may then lead to very expensive additional psychological and psychiatric consultations. If the results of this testing raises concern for alcoholism, then the pilot is referred for formal treatment (and can then plan on a long and complicated process of ongoing monitoring of his/her sobriety prior to regaining FAA medical certification).

The FAA is understandably concerned as to whether a pilot's alcohol usage might potentially affect his performance adversely, thus compromising safety. This is part of the “Zero Tolerance” policy referred to elsewhere in this text.

While *sometimes* a pilot with a single DUI *might* be able to obtain a medical certificate without too much difficulty, clearly in cases of multiple DUI's both the health of the pilot and his aviation career might be in jeopardy. It is therefore very important to avoid using drugs and alcohol from the start, thus ensuring that the pilot has a better chance of a long and successful flying career.

In the item where it asks about nontraffic misdemeanors, or felonies, one may ask, ‘Why do they want to know that?’ If a person has 3 arrests for domestic violence and 2 arrests for DUI, then the FAA may have concerns that this person has psychological issues or a personality disorder that would preclude them from being a safe pilot. Below the history items to be checked *yes* or *no*, the pilot is given an area to give brief explanations for these conditions. From a review of these explanations, the AME can best determine if the pilot can be issued a medical certificate at the time of the exam, and, if so, what comments should be made regarding that issuance.

When a pilot signs this form, this is the end of the pilot's reporting responsibility with the FAA (unless the FAA later requests additional data or clarifications). It also gives the FAA permission to contact the National Driver Register and serves as a disclaimer that the information given is true. It reminds the candidate that there are significant penalties for dishonesty. If the FAA finds out that the can-

didate has been dishonest, he or she can not only lose their medical certificate, but risks revocation of all pilot certificates too. As a worst-case scenario, especially in the event of an accident, litigation is almost always involved. In the vast majority of cases, honesty will end up being in the pilot's favor, since medical records are almost always subpoenaed after an accident.

Once the AME has reviewed the 8500-8 form and has found no disqualifying history items, then a full head-to-toe exam is administered.

Elsewhere in this book is a 'Synopsis' of the basic measurable standards. These include: vision, heart rate, blood pressure, hearing, etc. Fortunately, in a generally healthy young pilot, rarely are there exam findings so concerning that they permanently preclude issuance of a medical certificate. Most abnormal findings can ultimately be corrected (e.g., blood pressure) or evaluated (e.g., heart murmur) sufficiently to determine that they do not place the pilot at undue risk. If the pilot does not have any disqualifying history or exam findings, then a medical certificate can be issued 'on the spot' by the AME.

What happens if a pilot does not meet the normal medical standards? As mentioned previously, there is a waiver process that can often get such a pilot back in the air. There are two types of waivers:

SODA (Statement of Demonstrated Ability) – These are issued for "static" defects that are not likely to change in the future. Typically, a one-time evaluation is all that is needed for these conditions. Some of the most common conditions that require a SODA are: defective color vision, monocularly, poor vision in one eye (such as from amblyopia, or lazy eye, as a child), and limb amputation. In addition to any required medical evaluations, a pilot may additionally need to undergo a medical flight test to obtain the SODA. This requires that the pilot meet with an FAA inspector. For defective color vision, all that might be necessary could be to have the control tower shine the light signals to the pilot (who is simply standing on the ramp with the FAA inspector). If the pilot correctly identifies the colors, a SODA can be issued. (Note; while defective color vision technically still requires a SODA, recently the FAA has simply been sending eligibility letters on this condition without requiring a formal SODA.) For most other conditions, the pilot will have to demonstrate his/her abilities in flight with the FAA inspector.

Special Issuance Authorization – These are typically issued for conditions that will require ongoing monitoring. The most common examples are: diabetes, heart disease, cardiac pacemaker, and follow-up after treatment for drug or alcohol abuse, to name a few. There

are other conditions that are not formal FAR Part 67 disqualifiers, but the FAA has decided to place them under the special issuance program. This includes conditions such as prostate, breast, or colon cancer, kidney stones, and thyroid disease, to name some common examples.

Remember, at all times between required FAA exams, FAR 61.53 applies. This rule puts the responsibility on the pilot to self assess on an ongoing basis as to his/her fitness to fly. The entire purpose of the aviation medicine FARs, FAA medical exams, and FAR 61.53 is to hopefully prevent 'sudden incapacitation' in flight.

Although we can get many pilots certified to fly even after significant medical illness, it behooves all pilots to maintain a healthy lifestyle. If we could eliminate obesity, smoking, and drug or alcohol abuse, we would likely prevent a high percentage of the medical illnesses that plague our society. Certainly, some luck and genetics play a role in this, but the responsibility is on the individual to do his/her best to stay healthy. This means to eat properly, maintain a healthy weight, get moderate exercise, and never smoke or abuse drugs and alcohol.



1.15 To be a Civil Air Patrol pilot, you're going to have to be "fit for flying." It takes commitment to a program of good health maintenance throughout your life.

Many pilots tell me they are ‘too busy’ to exercise. That is simply not the case. While certainly there will be an occasional day when a schedule will not allow for exercise, in reality there is time to exercise on more days than not, regardless of the kind of job someone has. Throughout college, medical school, residency, and juggling two jobs (including a busy international flight schedule) I have exercised most days since childhood. In fact, I have run almost every day since 1969. I know you can do it. Exercise is as good for the mind as it is for the body.

And, finally, if a medical problem does require evaluation, don’t shy away from obtaining appropriate care over the fear of ‘opening the proverbial can of worms’ with the FAA. As with many mechanical problems, the sooner we can treat a medical problem the more likely we are to prevent major complications. Remember, it’s easier for me to keep you flying if you are still alive.”

PART TWO

— The Flying Environment —



2.1 This is home base, "Space Ship Earth," as seen from Apollo 10 on May 1969.

Mother Earth is actually a space ship

We call this “space ship” home and we exist within just a few feet of its surface. As a habitat for humans, it’s really quite a good one. The air we breathe is approximately 78-79% nitrogen and 19-21% oxygen plus a 2% mixture of other gasses. We breathe oxygen in and breathe carbon dioxide out.

The land surface of our habitat is made up of:

- Oxygen 46.6%
- Silicon 27.8%
- Aluminum 8.1%
- Iron 5%
- Calcium 3.6%
- Potassium 2.6%
- Magnesium 2%
- Trace elements 1.6%

Because the surface of the earth is 75% water and 25% land, the living conditions on this planet are relatively stable. In Hawaii, for example, the year-round daytime temperature in Honolulu averages 85°F and the average night-time temperature is 75°F. Water has a stabilizing effect on the atmosphere and helps to keep this planet mild compared to other places, like the moon. The moon has an average daytime temperature of 225°F and, at night, it “dips” to -243°F. The average temperature here on the earth is a balmy 59°F.

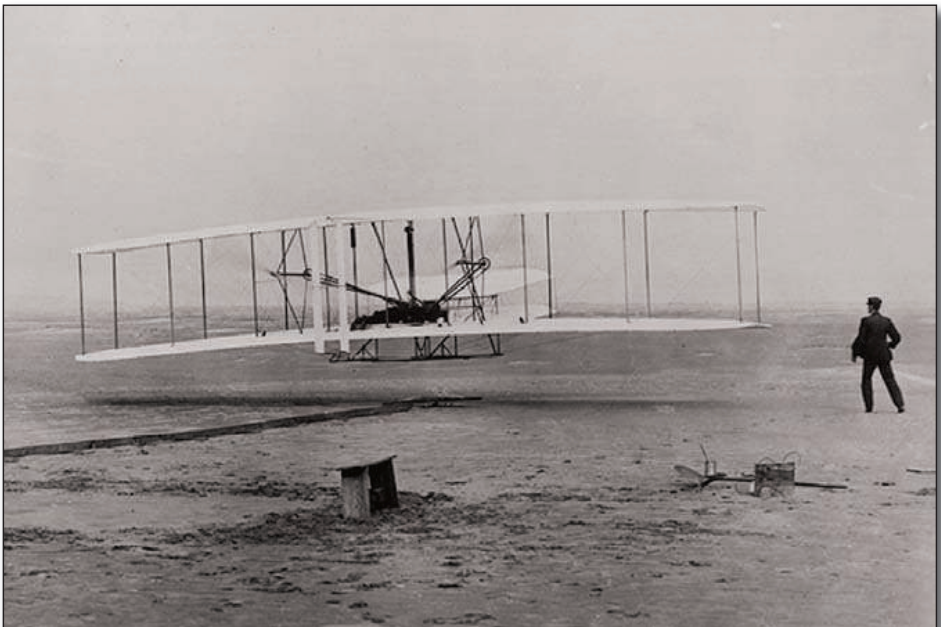
Conquering the air

On December 17, 1903, Orville and Wilbur Wright performed the famous first controlled, powered, and sustained flight. The next day newspapers hailed the Wrights with headlines that said they had “conquered the air.” Before the Wrights, many other brave souls tried to fly, and a few even made “hops” only to settle back to the earth’s surface due to the ever-present force of gravity. In order to “conquer” the air, three requirements had to be met. First, a flying machine had to be controlled. Otherwise, it would be no more than a kite without a string. Second, to keep it up in the air, it also had to be powered. Third, the flight of the vehicle had to be sustained.

After extensive testing, Orville and Wilbur Wright built a machine that met all three of these requirements. The facts surrounding the first flight can more easily be remembered by the number 12. The aircraft remained in the air for 12 seconds, the altitude achieved was 12 feet, and the little aircraft went 120 feet in forward flight.

For centuries, our ancestors thought that we needed wings that flapped; however, the Wrights proved that didn't work. Man tried to flap his arms, but he quickly learned that fixed-wings worked much better. Leonardo DaVinci (1452-1519) envisioned numerous flying devices, but the technology of his time wouldn't allow him to build a machine strong enough to be tested.

Englishman, Sir George Cayley, considered by many aviation historians to be the first true aeronautical engineer, developed several machines that had flying potential. He is given credit for inventing the first cambered (or curved) airfoil, which provides lift. He also recognized the four vectored forces of lift, drag, thrust, and gravity as they are related to an aircraft. He wrote a landmark book called *On Aerial Navigation* in 1809, almost 100 years before the Wright brothers' first flight. Once the Wright brothers conquered the air, aviation literally "took off."



2.2 The Wright "Flyer" flew a distance of 120 feet forward. It rose to an altitude of 12 feet and the event took 12 seconds. The Wright brothers had achieved controlled, powered, and sustained flight. The Wright brothers did their flying close to the Atlantic Ocean and most of their flight trials took place near the town of Kittyhawk, North Carolina. (Image courtesy of the National Air & Space Museum)

Man in the atmosphere — aviation physiology

When, in the early part of the 20th century, pioneering aviators were constantly trying to go higher and higher in an effort to break previous altitude records, it was soon discovered that a human couldn't breathe very well "up there." During early altitude record attempts, the symptoms of hypoxia were recognized. Hypoxia is a condition that occurs when the body is deprived of an adequate oxygen supply. Hypoxia varies with the individual and to some degree the circumstances, but it is generally found that man starts having problems at altitudes above 10,000 feet. Symptoms include headache, fatigue, euphoria, and even unconsciousness.

Breathing is one of the most automatic things we do—over 20,000 times a day to be exact. Each breath does two things for our body. First, it expels carbon dioxide when we exhale, and, second, it brings in oxygen when we inhale. Thus, hypoxia can be a



2.3 These pilots are preparing for a "flight" in a high altitude chamber. A flight physiology technician briefs them on the oxygen equipment and the symptoms of hypoxia.

real problem in high altitude flight.

Although the percentage of oxygen contained in the air at 18,000 feet is identical to that at sea level, the amount of air our lungs take in with each breath contains half the oxygen found at sea level. Breathing faster or more deeply doesn't help. In fact, because you're consciously over-riding a system that is normally automatic, you'll be compounding the problem by exhaling too much carbon dioxide.

For the majority of pilots, the answer to hypoxia is simple — use supplemental oxygen. (Federal Air Regulation) FAR 91.21 specifies a 30-minute limit before oxygen is required on flights between 12,500 feet and 14,000 feet and immediately upon exposure to cabin pressures above 14,000 feet. The FAA recommends that you go on supplemental oxygen above 10,000 feet.

At night, because vision is particularly sensitive to diminished oxygen, a prudent rule is to use supplemental oxygen when flying above 6,000 feet. So when flying at high altitudes, supplemental oxygen is the only solution because it satisfies the twin purposes of having enough oxygen to meet the body's demands and also maintaining a breathing rate that excretes the right amount of carbon dioxide.

REDLINE: Unfortunately, our bodies do not give us a reliable signal at the onset of oxygen starvation. Unless you have received special training to recognize the symptoms, you may not even know it is happening to you. The brain is the first part of the body to reflect a diminished oxygen supply and the evidence of that is usually a loss of judgment.

In controlled chamber tests, where high-altitude flight conditions can be duplicated, it has been shown that some people in an oxygen-deficient environment actually experience a sense of well-being or euphoria. When hypoxia reaches a certain stage, many subjects participating in altitude chamber training, can't even write their own names intelligibly.

As we venture higher into the sky, it becomes more threatening!

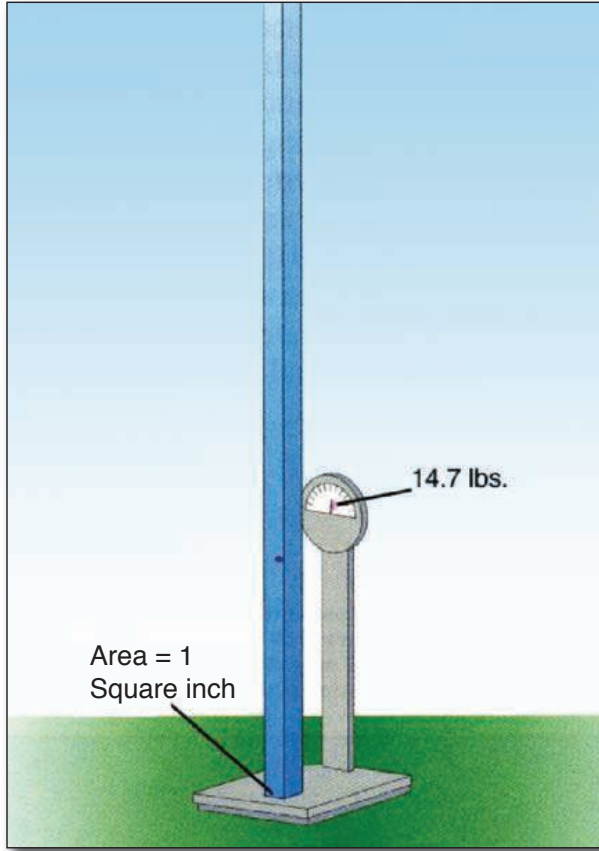
It is a scientific fact that air at sea level has an average pressure of 14.7 pounds per square inch. The term "mean sea level" is commonly referred to as "MSL."

Since the ocean covers most of the earth, at least 75% or more of the earth's surface is at "sea level." Because so much of what we do in aviation involves pressure changes, the starting point for a study of this phenomenon is right at the beach (sea level) on a 59°F (standard

2.4 This is a one-inch, square tube that is more than 100 miles tall. Inside the tube would be a sample of air weighing 14.7 pounds.

world-wide) day.

An average adult has approximately 3,000 square inches of skin surface area. At sea level, with 14.7 pounds per square inch of air pushing down on our bodies, that's a total of 44,100 pounds of pressure. You don't really feel uncomfortable because your body is designed so that it pushes back with a pressure equal to the weight of air.



You may have heard grandmothers or grandfathers say, “The weather is going to change.” How could they know? When cold or warm fronts move, the pressure ahead of the front changes dramatically. A fast-moving cold front is especially significant because the barometric pressure can drop an inch or more in just a few hours. If the pressure on the outside skin of a grandfather’s knees drops, he will feel it, especially in joints and areas where it’s tender.

When you look at Illustration 2.4, the blue tube is one inch on each side, but (for explanation purposes only) it’s more than 60 miles long. Science demonstrates there’s a sample of air trapped inside a tube, and it weighs 14.7 pounds. Over the years, scientists have taken thousands of readings around the the planet and that’s how they eventually determined the average weight of air.

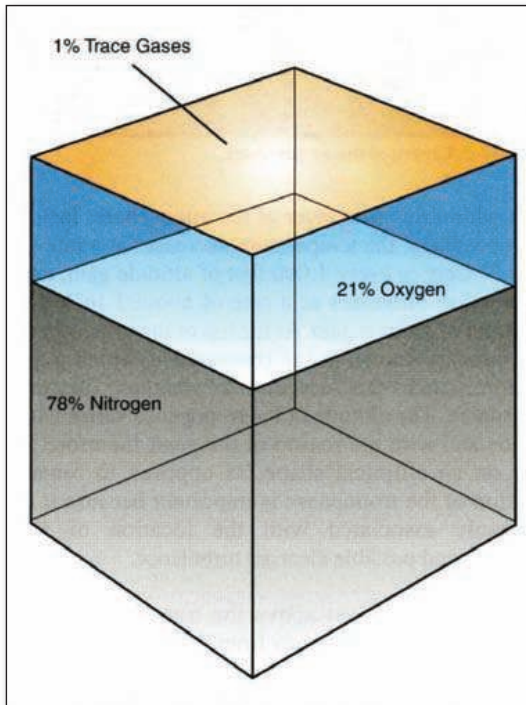
It is generally accepted that a healthy human can be comfortable anywhere between sea level and 6,000 feet, but a form of altitude sickness can occur even in a city like Denver, which is at an average altitude of 5,280 feet. It is common for people from lower elevation

cities to experience headaches when they visit places like Colorado Springs (6,035 feet), Mexico City (7,347 feet), Aspen (7,890 feet), or Leadville, Colorado (10,152 feet) above sea level.

Take, for example, a San Diego couple who decides to go on a vacation skiing in Winter Park, Colorado. When the couple boards one of the more advanced chairlifts, they will be starting at an elevation of more than 9,000 feet and will then spend a portion of their day skiing on terrain that is nearly two miles high, 10,560 feet. When they left San Diego, the barometric pressure was probably close to the sea-level standard of 29.92 inches. Since, for every 1,000 feet of altitude gained, the barometric pressure drops by about one inch. The standard pressure at 10,000 feet will now be 20.58 inches with a standard temperature of 23.4°F.

If we don't have as much air pushing down on us from the outside and we still have fluids pressing from the inside, this might cause headaches and other problems not normally experienced at sea-level. The air in Winter Park is very dry and because the San Diego couple tends to breathe a little bit faster, they may also experience dehydration. These symptoms may be the cause of what is called "altitude sickness."

Altitude sickness



Sometimes called Acute Mountain Sickness, or AMS, altitude sickness occurs when someone feels sick at high altitudes. Medical science is not exactly sure what causes this, but it seems to be most prevalent in healthy human beings at altitudes starting around 6,500 feet. Symptoms generally include headache, fatigue, nausea, and some dizziness. Altitude sickness can also follow a rapid climb and researchers have

*2.5 The atmosphere has the same percentage of these elements all the way to the top.
(Image courtesy of the FAA)*

found that one way to reduce the problem is to ascend more slowly to give the body time to “acclimatize.”

Since the body tends to dehydrate with a gain in altitude, physicians recommend that climbers, skiers, flight crews, and passengers drink plenty of water. Alcohol tends to dehydrate the human body and people who are going to work or play at higher altitudes should avoid alcoholic consumption 24 hours prior to action. If the symptoms of AMS occur, medical professionals advise going to a lower elevation and, if symptoms continue, seeking medical attention. The symptoms include:

- Headaches
- Drowsiness
- Malaise (feeling “out of sorts” or uneasy)
- Dizziness
- Light-headedness
- Fatigue
- Shortness of breath
- Higher than normal, or rapid, pulse rate

For any of the following symptoms, the situation may be more serious and you should seek medical help immediately:

- Fever
- Persistent dry coughing
- Headache that does not respond to pain medication

At very high altitudes, humans can experience a condition known as “High Altitude Pulmonary Edema” (HAPE), and although the exact cause is unknown, it is a serious threat. Another threat is “High Altitude Cerebral Edema” (HACE). HACE is a rare but life-threatening condition involving the brain that can lead to a coma or death. Symptoms include headache, fatigue, visual impairment, bladder and bowel dysfunction, and loss of coordination. The person experiencing any or all of these symptoms must get to a lower altitude immediately and seek medical attention. Supplemental oxygen given immediately can be a life-saving solution.

Adapting to the higher altitude environment

There are two major problems facing humans at higher altitudes: (1) the extremes of temperature can cause an increase in stress; and (2) the lower humidity and pressure can cause rapid dehydration. At

sea level, oxygen can easily pass through the lung's membranes and into the bloodstream. The body will react with an increase in breathing and heart rate. Blood pressure also increases as the heart works harder to get oxygen to the cells.

If a human stays at higher elevations, over time, a response should occur in the form of "acclimatization." More red blood cells are produced resulting in more oxygen to the tissues, and there is also an increase in the vascular network which enhances the transfer of gases.

Some civilizations have been able to live at altitudes up around 13,000 feet. Those civilizations are in the mountains of Peru, Bolivia, Tibet and Nepal. The people developed the ability to survive where the pressure is less and the oxygen is diminished. They have a higher number of red blood cells to get more oxygen to the tissues, and they also breathe faster.

In the world of athletic competition, numerous Olympic training centers are located in mountainous areas to take advantage of the changes that occur in athletes who have spent weeks or months living at the higher elevations. Although the body will eventually return to its original fitness state at sea level, there is a short-term advantage that gives athletes a higher level of performance having trained in the mountains.

The atmosphere is a mixture of gases

The atmosphere is a mixture of gases that surround the earth. Air is a thin layer of gases that is heaviest (most dense) close to the surface. For pilots, the earth's troposphere may be considered a "second home;" however, high performance aircraft, such as fighters or airliners, operate in a layer known as the stratosphere. This blanket of gases provides protection from ultraviolet rays, as well as supporting all animal and plant life, including humans. Nitrogen accounts for 78-79% of the gases and oxygen makes up 19-21%. Carbon dioxide, argon, and other trace elements make up the remaining percentages.

Within this envelope of gases, there are several layers defined, not only by altitude, but also by different characteristics. The first layer is known as the troposphere. It extends from sea level up to 20,000 feet over the poles and goes up to as high as 49,000 feet above the equator. The majority of our weather, clouds, storms and temperature occur within this layer. Inside the troposphere, the temperature decreases at a rate of 2° (approximately 3.5°F) every 1,000 feet of altitude. The pressure decreases at a rate of one inch per 1,000 feet gained.

At the top of the troposphere there exists a boundary layer known

as the tropopause. The altitude of this layer varies with the latitude and with the season of the year. If the tropopause could be viewed from space, the shape would look elliptical. It is commonly associated with the location of the jetstream and clear-air turbulence.

The atmospheric level above the tropopause is the stratosphere which extends from the tropopause to a height of about 160,000 feet. Very little weather exists in this layer and the air is reasonably stable. At the top of the stratosphere is another boundary known as the stratopause. Directly above this is the mesosphere, which extends to the mesopause boundary at about 280,000 feet. The temperature in the mesosphere decreases dramatically with an increase in altitude and can be -90° below zero. The next layer is the thermosphere. It starts above the mesosphere and gradually fades into space.

Partial pressure at higher altitudes

At sea level, atmospheric pressure is great enough to support normal growth, activity, and life. At 18,000 feet, however, the pressure of oxygen is significantly reduced to the point that it adversely affects the normal activities and functioning of the human body. This is known as “the partial pressure of a gas.”

The physiological reactions to oxygen deprivation are insidious and affect people in different ways. These symptoms range from mild disorientation to total incapacitation depending on body tolerance and altitude. By using supplemental oxygen or cabin pressurization systems, pilots can fly at higher altitudes and overcome the adverse effects of oxygen deprivation.



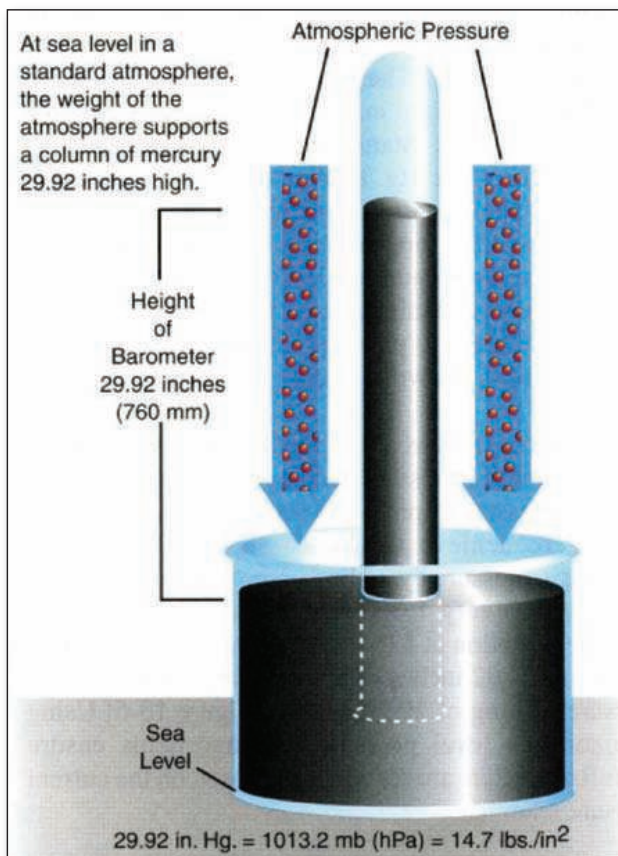
2.6 In the old days, they called it “CAVU.” This meant it was “Clear And Visibility Unlimited.” (CAP photo)

Measuring atmospheric pressure

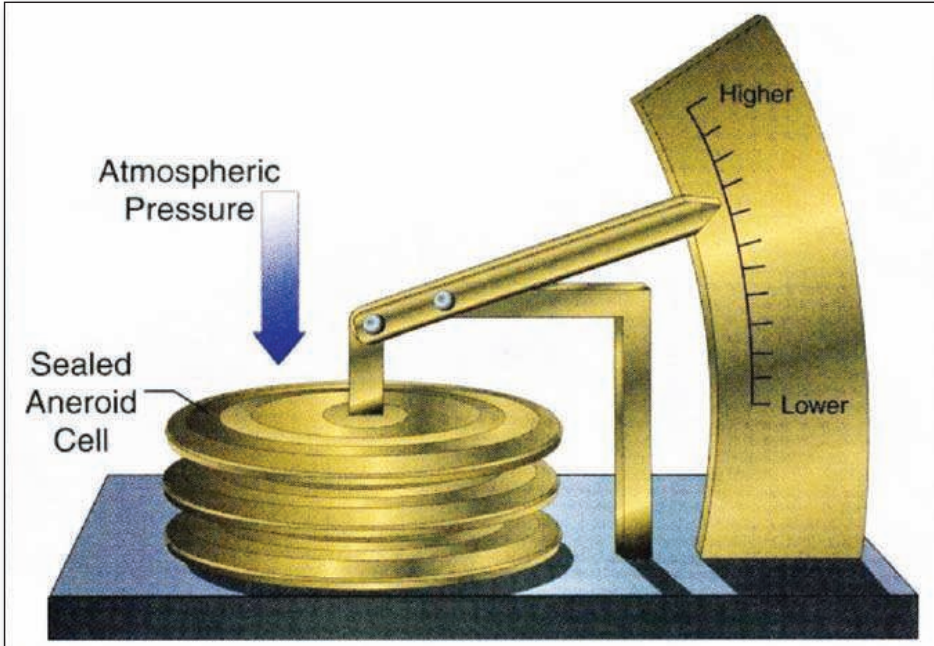
The atmospheric pressure is measured with an apparatus using the element mercury. Under standard conditions, mercury is a liquid metal and has a chemical symbol of Hg. The measuring device is known as a Torricelli Barometer. The word *baro* means pressure and *meter* means to measure. The Torricelli Barometer is a column of mercury inside a glass tube that is sealed at one end and open at the other. In a standardized laboratory setting when the tube is inverted and allowed to pour out into a bowl (or open container like a small beaker), the mercury will drain out and then stop when a vacuum develops inside the tube. Under standard conditions at sea level, this column of mercury will stabilize at 29.92 inches above the surface of the mercury in the bowl. This kind of barometer is not very easy to work with and it is difficult to read. But, it was a beginning in the field of pressure measurement.

There is an alternative to the mercury apparatus called the Aneroid Barometer which contains a closed cell that is shaped like a bellows. Because of its shape and the air trapped inside it when the

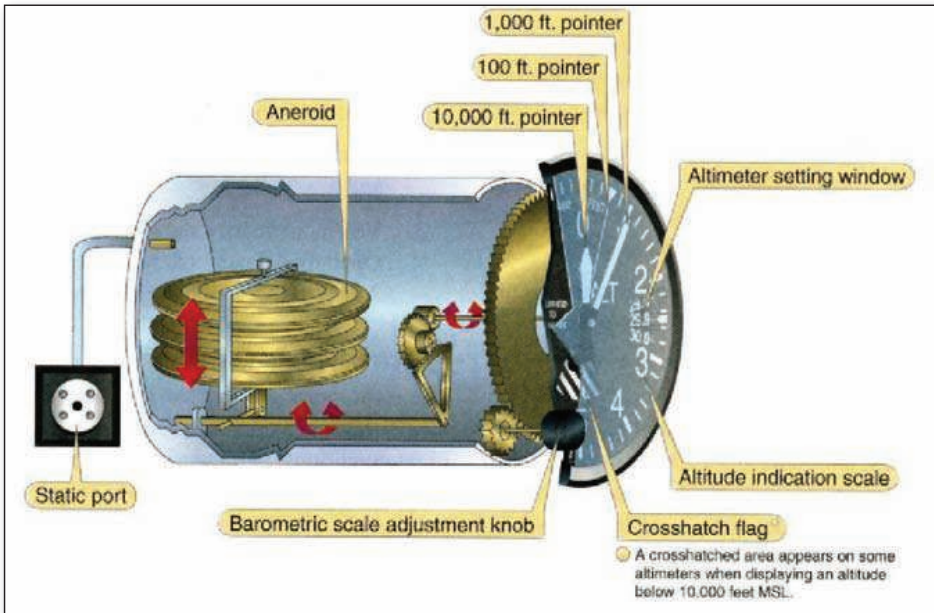
outside pressure changes, the bellows will expand or contract. A small pointer is placed on the center of the cell and the attached mechanism allows the observer to see changes in the bellows. Although not



2.7 This is an example of a Mercurial or Torricelli Barometer. The black fluid is mercury and the open end, shown by the dashed white line, has been inserted into the container. A vacuum exists above the mercury and that is the light blue area in the closed end of the tube. (Illustration is courtesy of the FAA)



2.8 This is an Aneroid Barometer. The sealed “aneroid cell” is like a bellows. It can expand or contract. When the outside air pressure is greater, it pushes down on the cell. This causes the reading to be higher. The opposite happens when the pressure becomes less. This allows the cell to expand and the reading becomes lower. (Illustration is courtesy of the FAA)



2.9 This is a cutaway of an altimeter. Notice the “aneroid cell” inside. As the airplane goes higher, there is less pressure on the cell and therefore it expands. This causes the pointers to change, indicating to the pilot that there has been an increase in altitude. (Illustration is courtesy of the FAA)

quite as accurate as the Mercurial Barometer, the Aneroid Barometer mechanism is much more mobile and can be used in the field.

As you go higher in the atmosphere, both the air pressure and density decrease. If you were to take a Mercurial Barometer and carefully hike up a local mountain that was 1,000 feet above your

TABLE OF U.S. STANDARD ATMOSPHERE					
FEET	In. of Hg	Mm of Hg	PSI	C	F
0	29.92	760.0	14.69	15.0	59.0
2,000	27.82	706.7	13.66	11.0	51.8
4,000	25.84	656.3	12.69	7.1	44.7
6,000	23.98	609.1	11.91	3.1	37.6
8,000	22.22	564.6	11.77	-0.8	30.5
10,000	20.58	522.7	10.10	-4.8	23.4
12,000	19.03	483.4	9.34	-8.8	16.2
14,000	17.57	446.5	8.63	-12.7	9.1
16,000	16.21	412.0	7.96	-16.7	1.9
18,000	14.94	379.7	7.34	-20.7	-5.1
20,000	13.75	349.5	6.76	-24.6	-12.3
22,000	12.63	321.3	6.21	-28.6	-19.4
24,000	11.59	294.9	5.70	-32.5	-26.5
26,000	10.62	270.3	5.22	-36.5	-33.6
28,000	9.72	237.4	4.78	-40.5	-40.7
30,000	8.89	226.1	4.37	-44.4	-47.8
32,000	8.10	206.3	3.99	-48.4	-54.9
34,000	7.38	188.0	3.63	-52.4	-62.0
36,000	6.71	171.0	3.30	-55.0	-69.7
38,000	6.09	155.5	3.00	-55.0	-69.7
40,000	5.53	141.2	2.73	-55.0	-69.7
42,000	5.03	128.3	2.48	-55.0	-69.7
44,000	4.56	116.6	2.25	-55.0	-69.7
46,000	4.15	105.9	2.05	-55.0	-69.7
48,000	3.77	96.3	1.86	-55.0	-69.7
50,000	3.42	87.4	1.70	-55.0	-69.7
55,000	2.70	68.8	1.33	TEMPERATURE REMAINS CONSTANT	
60,000	2.12	54.4	1.05		
63,000	1.83	46.9	.907		
64,000	1.74	44.7	.86		
70,000	1.31	33.5	113.2(psf)		
74,000	1.08	27.7	77.3		
80,000	.82	20.9	58.1		
84,000	.68	17.3	47.9		
90,000	.51	13.0	35.90		
94,000	.42	10.9	29.97		
100,000	.32	8.0	22.30		

Source: U.S. Standard Atmosphere - 1962

(TABLE 6)

In. of Hg = Inches of Mercury

C = Centigrade

Mm of Hg = Millimeters of Mercury

F = Fahrenheit

PSI = Pounds per square inch

PSF = Pounds per square foot

2.10 This table shows the amount of drop there is with temperature and pressure up to 100,000 feet.

sea-level laboratory, you would find that the mercury inside would drop approximately one inch.

Because the Aneroid Barometer is reasonably accurate throughout a wide range of pressure changes and because it is compact, it became the basis of an airplane's altimeter. Pressure changes are converted to increments of altitude. When a pilot goes through a prestart checklist, one of the required tasks is to set the current barometric pressure into the altimeter. This setting recalibrates the aneroid barometer, and, assuming the current pressure is correct, the altimeter will read the exact elevation of the aircraft above sea level. This recalibration process also occurs in flight so that the pilot can take into account changes in barometric pressure along the flight route.

Density altitude

The higher we go into the atmosphere, the greater the decrease in pressure at a predictable rate. The density of the air also decreases. Density is defined as “mass per unit volume.”

As an aircraft climbs higher and higher away from the earth, the surrounding air becomes less dense. As the density decreases, the airplane's lifting performance will also become less. An example of this is a loaded airliner taking off from New Orleans on a calm springtime day where it's 59°F. Under these conditions, the aircraft will most likely be off in 5,000 to 6,000 feet. If it's a hot, humid day in Denver that aircraft may take as much as 8,500 feet to become airborne.



2.11 On hot days at high altitude airports, airplanes don't get off the ground as quickly because the air density is less. Although the actual airport altitude may be 5,431 feet, the airplane is performing like it would at 8,000 feet or higher. This is known as high density altitude. (Photo by Adam Wright)

Because of this decrease in the density of the air, the science of aviation calls it density altitude.

Instructors like catchy phrases to help pilots remember threatening conditions. In this case, it is “high, hot, and humid,” three performance factors that can have a negative effect not only on climb performance but also on engine output and propeller effectiveness.

Aircraft performance involves many factors: takeoff and landing distance, rate of climb, ceiling, payload, range, and fuel economy, just to mention a few. Some of these factors involve compromises such as high speed versus landing distance, long range versus payload, and the rate of climb versus fuel economy.

Pilot performance is also involved in this equation so an individual has to be in top physical condition to effectively operate a high-performance aircraft.

As the human moves away from the surface of the Earth, less oxy-



2.12 High-performance pilot; high-performance crew chief; high-performance aircraft. The pilot and crew chief stay in top physical condition by working out and running at least four times per week. The F-16 constantly gets quality control checks to make sure that it is capable of entering a combat environment with every possible component functioning at its peak. The Air Force requires that their flight and ground personnel be in exactly the same or better physical condition than they were at their last physical examination.

*(Image is courtesy of Lt. Col. Patrick Hanlon,
USAF Air National Guard Director of Operations, 120th Fighter Squadron
140th Wing, Buckley Air Force Base in Colorado)*

gen is available and there is a decrease in pressure. With a decrease in both oxygen and pressure, steps must be taken to maintain what the body, most notably the brain, needs to maximize operational skill and efficiency. The human body is like a machine, so physical conditioning is a factor in the body's performance.

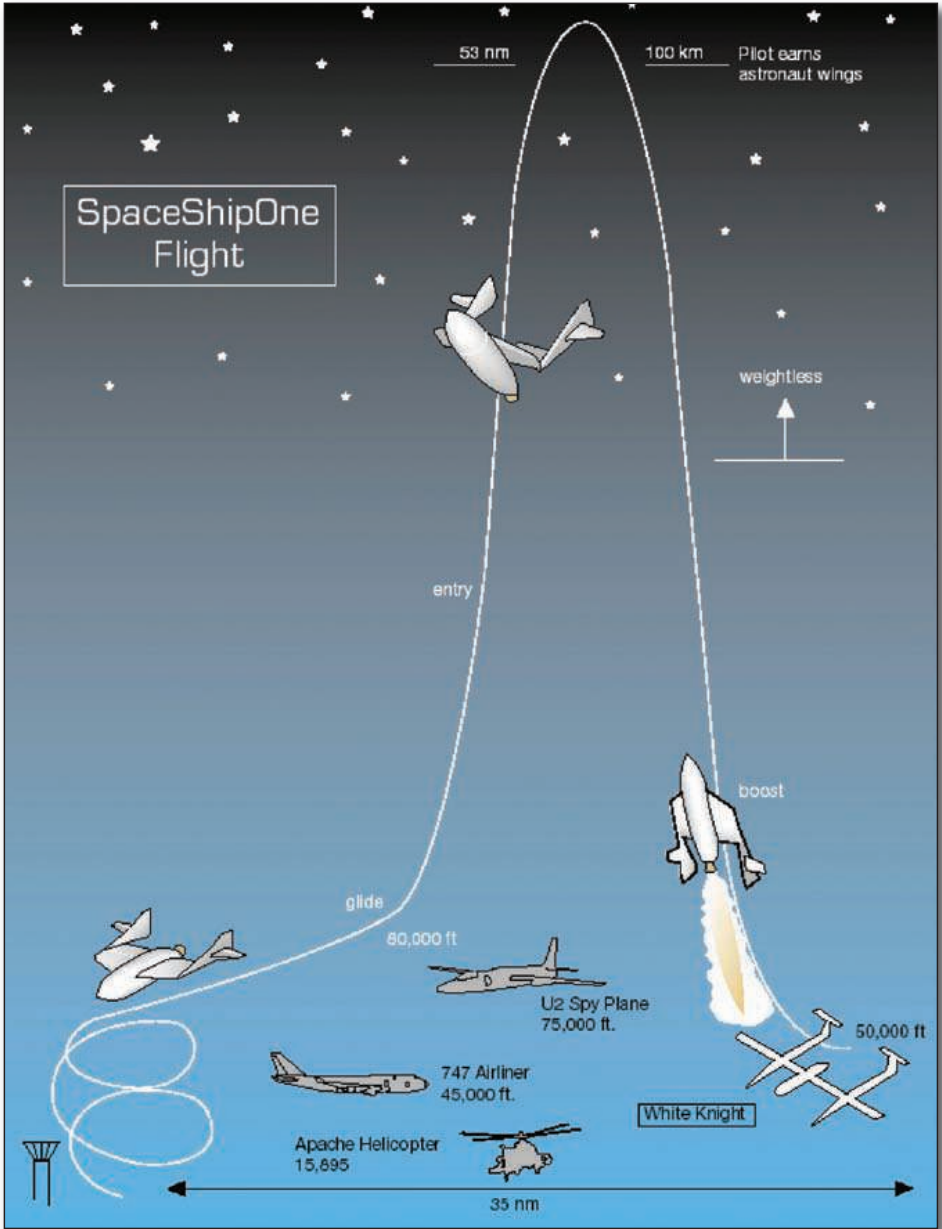
The airplane and the human become one in performance terms. If the aircraft is being used in a capacity where high speed and high altitude are part of the requirements, then a high performance pilot is required to get the machine to perform at its expected potential. That is one of the reasons why the FAA requires a physical examination for all certificated pilots throughout all of their flying experience.

Atmospheric temperature changes

Something else enters the picture and it is called differential heating. This simply means that the heat drops as the aircraft climbs or descends higher. For instance, the outside air temperature (OAT) gauge on a high-flying jet shows that it gets colder and colder outside the higher we climb. Then at an altitude up around 10 miles above the earth, something dramatically changes. The temperature begins to get warmer. As we go higher to altitudes above 50,000 feet (as Burt Rutan's *Space Ship One* did when it broke the record for the first private-venture flight into space – illustration on page 51), it starts to get cold again and up near 80,000 feet the temperature drops to -80°F. At 90,000 feet, it once again gets warmer.

Why, you ask? The air above the earth is heated by the sun. The rays from the sun strike the earth at a very low angle at the poles and almost vertically at the equator. The sun's radiation heats the air and this, subsequently, heats the air at a different rate above the earth's surface.

More heat is radiated into the air at the equator than at the poles causing the air to rise higher. All the sphere divisions have their own characteristics. The troposphere goes from sea level to 50,000 feet high at the equator. It has variable temperatures, water vapor, turbulent storms, weather and temperature lapse rates. The stratosphere occurs near 50 miles high. It has a relatively constant temperature, which is around -55 C; very little water vapor; jet streams; and not much turbulence. The ionosphere exists between 50-90 miles high. It provides protection from UV rays and gets its name from the ionized gases within. The thermosphere exists between 90-120 miles high above the equator. Due to the intense

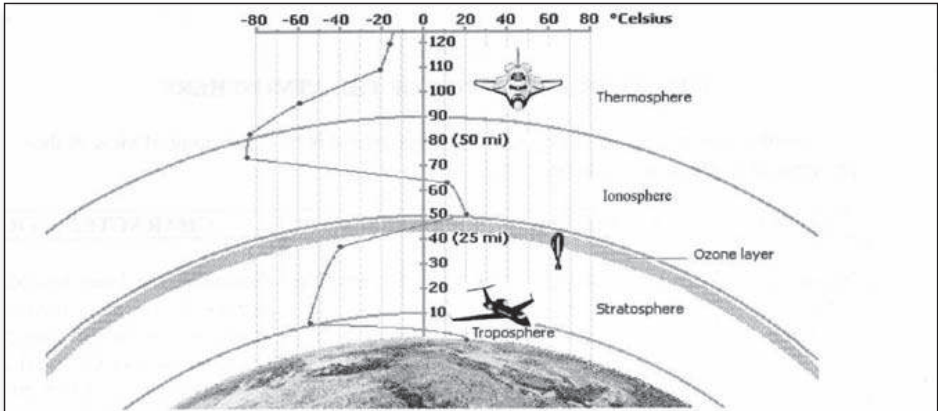


2.13 The first private flight into space was by SpaceShipOne. A pilot earns his/her astronaut wings for flying into space at 53 nm/100 km. (Image is courtesy of Scaled Composites of Mojave Aerospace Ventures, LLC)

solar radiation and lack of gaseous molecules, the temperature in this layer can soar to over 1,000°C. The top layer is called the exosphere and is found between 120 and 1,000 miles high above the equator. It has a very low pressure and density because molecules there rarely collide. And, finally, at 1,000 miles above the Earth the molecules are almost nonexistent.

Divisions of the atmosphere

Compare illustrations 2.14 and 2.15. This an excellent visual overview of the atmosphere and the dangers one encounters the higher we fly. It is strongly recommended that pilots take advantage of the FAA’s aviation physiology courses where they can experience some of these threats in a controlled altitude chamber setting.






PHYSICAL DIVISIONS OF THE ATMOSPHERE

The envelope of air that surrounds the earth varies in pressure and temperature throughout its entire height. This is due to differential heating of the air by heat radiated from the earth. The rays from the sun strike the earth at a very low angle at the poles and almost vertically at the equator. Thus, more heat is radiated into the air at the equator than at the poles causing the air to rise higher which can vary the heights of the Troposphere division listed below. All the divisions of the atmosphere have their own special characteristics that separate them from the others.

DIVISIONS	ALTITUDES	CHARACTERISTICS
Troposphere	Sea Level - 30,000 (poles) to 50,000 (equator) feet	Variable temperature, water vapor, turbulence, storms, weather, temperature lapse rate
Stratosphere	50,000 feet - 50 miles	Relatively constant temperature of -55 degrees Celsius, little water vapor, jet streams, little turbulence
Ionosphere	50 miles - 90 miles	Provides protection from UV rays, gets name from the ionized gas within this layer (UV rays strip electrons from gaseous molecules and creates ions)
Thermosphere	90 miles - 120 miles	Due to intense solar radiation and the lack of gaseous molecules the temperature can soar over 1000 degrees Celsius.
Exosphere	120 miles – 1000 miles	Gradually becomes the vacuum of space, so little pressure and density that gaseous molecules rarely collide
Space	Over 1000 miles	

2.14 The Physical Divisions of the Atmosphere. (FAA Illustration)

PHYSIOLOGICAL ZONES OF THE ATMOSPHERE			
Another way to classify divisions of the atmosphere is from the point of view of the physiological effects on the human body.			
ZONES	ALTITUDES	PRESSURE	CHARACTERISTICS
Physiological Efficient Zone 	Sea Level - 12,500 feet	760 - 523 mm/Hg	Generally, the body has adapted to operate in the lower regions of this zone. Minor trapped gas problems (ears, sinus, and GI tract) occur in the lower region of this zone while shortness of breath, dizziness, headaches and fatigue in the upper region if exposure too long
Physiological Deficient Zone 	12,500 - 50,000 feet	523 - 87 mm/Hg	The majority of flying is conducted in this zone. The lack of atmospheric pressure causes major physiological problems...hypoxia and decompression sickness
Space Equivalent Zone 	50,000 ft - 1000 miles	87 - 0 mm /Hg	This environment is very hostile to humans. "Armstrong's line" is at 63,000 feet and any unprotected exposure above this level causes body fluids to boil. There is a need for a sealed cabin and thrusters on the air/space craft.

2.15 These divisions clearly show how dangerous it is in the upper reaches of the atmosphere. Without protection and supplemental oxygen, the human has only seconds to live at the beginning of the "Space Equivalent Zone." (FAA Illustration)

**The earth's atmosphere is awesome to behold—
yet can be incredibly dangerous**

Without the atmosphere there would be no life on Earth. The atmosphere provides protection from harmful ultraviolet rays, cosmic rays, and meteorites, as well as extreme temperature variations. It supports animal and plant life through its gaseous content and provides rain to grow crops. It protects us from all sorts of dangers. And it helps us sustain life with its oxygen and nitrogen content. It is an incredibly beautiful planet but, like the ocean, the air surrounding it can be deadly.



2.16 It is highly recommended that all pilots take one of the FAA's aviation physiology courses. They are usually held at Air Force bases that have high altitude chambers like the one pictured from Peterson AFB. The cost is minimal and the experience is "priceless."

PART THREE

— Aerophysiology —



Aeromedical and aerophysiology



3.1 *Aerophysiology is the human element in the flight of an aircraft. Air Force Captain Scott Kotowski hooks up his oxygen equipment in preparation for a flight in an F-16. (USAF image is by Sgt. Jack Braden)*

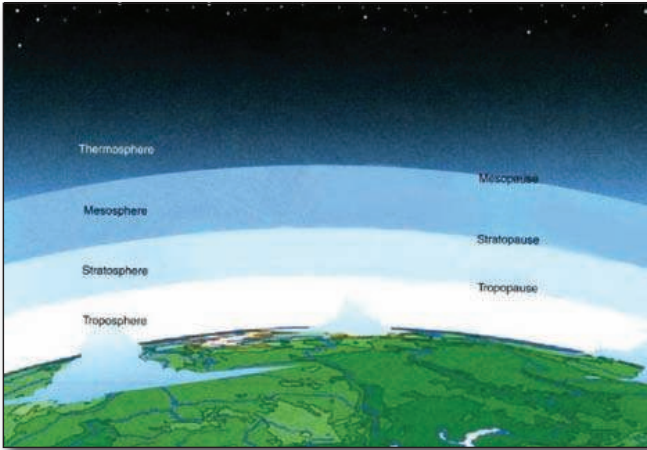
When the “space age” was introduced by Sputnik, the Soviet Union’s satellite back in the late 1950s, someone coined the new term aerospace. This was a combination of the word *aero*, which means within our atmosphere, and *space*, which means the realm beyond our atmosphere.

Aeromedical is the science of medicine as it relates to human flight within our atmosphere. As we learned in the “Flight Environment” section, 20th century human flight has been extended into the stratosphere. *SpaceShipOne*, the private space venture of Burt Rutan and the Scaled Composites crew, flew to an altitude of 100 kilometers or 62 miles high. This has been designated as the official beginning of space. Thus, aeromedical is taking on a new dimension as man travels farther beyond the Earth’s atmosphere.

Aerophysiology is all about the aircraft becoming an extension of the human. In a sense, the human is a very complex computer that controls the flying machine. When operating an aircraft, it is extremely important that this human *computer* be at his/her peak per-



3.2 *SpaceShipOne (Image courtesy of the Experimental Aircraft Association)*



3.3 *The troposphere is the white layer just above the surface. The light blue layer just above that is the stratosphere.*
(FAA Illustration)

formance as it works in the flight environment. It's an environment with less oxygen, less nitrogen, and less pressure, not to mention volatile weather and extremes in temperature. Safety is critical in aviation and it is highly recommended that pilots, from Light Sport Aircraft to the most sophisticated international transports, continually study the science of aerophysiology.

In this section, the term *aerophysiology* covers some of the basics of human physiology as it relates to flying, mostly within the troposphere.

Highly publicized events involving aerophysiology

Recently, a charter pilot went into a diabetic coma and one of his passengers, a student pilot, landed the airplane. An investigation found that the pilot did not disclose his diabetic condition to the FAA on a previous medical examination, and, after a trial, lost his flying privileges and also received a jail sentence.

Another high-profile event, involving aerophysiology was the death of the 1999 U.S. Open Champion, Payne Stewart. This very popular world-class golfer died in the crash of a corporate jet. On the 25th of October 1999, Stewart, the pilots, and three associates were on a trip from Florida to Texas. After departing from Orlando airport, Air Traffic Control lost voice contact with the flight crew. A USAF F-16 scrambled to try and make visual contact with the Lear 35. Upon arrival, the F-16 pilot reported that the windows of the Lear were obscured by frost and condensation. At times, along the final route of flight, it was reported that the Lear was flying above flight level 460, which is 46,000 feet. Shortly thereafter the aircraft crashed near Aberdeen, South Dakota. In a later report, National Transportation Safety Board (NTSB) investigators concluded that all

Altitude	Time of Useful Consciousness
45,000 feet MSL	9 to 15 seconds
40,000 feet MSL	15 to 20 seconds
35,000 feet MSL	30 to 60 seconds
30,000 feet MSL	1 to 2 minutes
28,000 feet MSL	2 1/2 to 3 minutes
25,000 feet MSL	3 to 5 minutes
22,000 feet MSL	5 to 10 minutes
20,000 feet MSL	30 minutes or more

3.4 This chart clearly shows that the crew and passengers of Payne Stewart's Lear 35 had between 9-15 seconds before they lost consciousness. It was reported that their aircraft was, at times, above 45,000 feet. (FAA illustration)

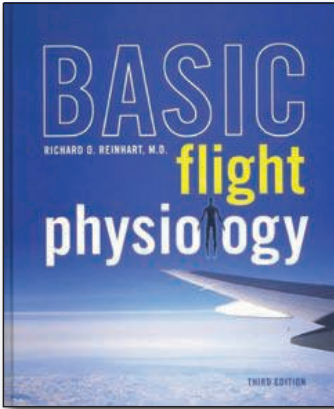


3.5 This is a Sport Jet II. This aircraft brings corporate jet performance to the world of home-built aviation. At 380 knots, it easily cruises at 28,000 feet for 900 miles. It does not require two pilots and will carry four in a luxury cabin. The cost is less than a million dollars to build and fly. (Image is courtesy of Excel Jet)

on board died of hypoxia. A delay of consciousness for only a few seconds, coupled with cognitive and motor skill impairment, may have resulted in the death of the flight crew.

(REDLINE) It is a known aerophysiological fact that the time of useful consciousness at 45,000 feet is between 9-15 seconds. At times, it was estimated the Lear was flying at or above 46,000 feet and experts concluded that everyone on that flight most likely lost consciousness and died almost immediately.

As technology surges forward by leaps and bounds, airplanes with much higher performance and altitude capability are becoming more affordable to the public. It has become a high priority educational mission for the FAA to make all pilots more aware of factors, such as hypoxia, hyperventilation, spatial disorientation, carbon monoxide



3.6 This book provides more in-depth research and is an excellent book for any pilot's library.

poisoning, stress, and fatigue, just to mention a few.

In an effort to support the FAA and their aeromedical safety education for pilots, *Fit For Flying* has been created to be an easy-to-read, comprehensive overview of the human element in aviation. For more in-depth information, the reader is directed to read the outstanding book, *Basic Flight Physiology*, by Dr. Richard O. Reinhart MD (ISBN 978-0-07-149488-5). Dr. Reinhart is not only a Senior Aviation Medical Examiner, but also an instrument-rated pilot. He has since retired, but served as an Air National Guard Flight Surgeon.

Basic Hypoxia

As has been briefly discussed, hypoxia means reduced oxygen. It is divided into four major groups based on individual causes: (1) hypoxic hypoxia, (2) hypemic hypoxia, (3) stagnant hypoxia, and (4) histotoxic hypoxia.

(REDLINE) Living tissue will die if deprived of oxygen long enough. Where humans are concerned, the highest priority is getting enough oxygen to the brain. Since the brain is particularly vulnerable to oxygen deprivation, any reduction while flying may cause mental disfunction and can result in a life-threatening situation.

Hypoxia can be caused by any of several factors including a diminished supply of oxygen, inadequate transportation of oxygen, or the inability of human body tissues to use the oxygen that is available.

Hypoxic hypoxia

This phenomenon is a result of not enough oxygen available to the lungs. A blocked airway is one example of how the lungs can be deprived of oxygen. The reduction in partial pressure of oxygen at high altitude is also an example which is common to pilots. Although the percentage of oxygen in the atmosphere is constant, its partial pressure decreases proportionately as atmospheric pressure decreases.

(REDLINE) As the airplane climbs, the percentage of each

gas in the atmosphere remains the same, but there are fewer molecules available as the pressure required for them to pass between the membranes decreases within the respiratory system. This decrease of oxygen molecules can lead to hypoxic hypoxia.

Hypemic hypoxia

When the blood is not able to take up and transport a sufficient amount of oxygen to the cells of the body, hypemic hypoxia occurs. This type of hypoxia is a result of oxygen deficiency in the blood rather than a lack of inhaled oxygen and can be caused by a variety of factors. It may be because there is not enough blood volume (such as severe bleeding) or it may result from certain blood diseases (such as anemia). More often, it is because hemoglobin, the actual blood molecule that carries oxygen to the cells, is chemically unable to bind oxygen molecules. **The most common form of hypemic hypoxia is carbon monoxide poisoning.**

Hypemic hypoxia can also be caused by the loss of blood from a blood donation. Blood can take several weeks to return to normal following a donation. Although the effects of the blood loss are slight, there are risks when flying during this time period.



3.7 Throughout the flight profile, there are dramatic changes in pressure, from 29.92 inches at sea level to 5.3 inches at 40,000 feet, and back again. (Image is courtesy of Ben Wang and Airlines.net)

Stagnant hypoxia

Stagnant means not flowing, and stagnant hypoxia results when the oxygen-rich blood in the lungs isn't moving to the tissues that need it. An arm or a leg that "goes to sleep" because the blood flow has accidentally been shut off can be an example of stagnant hypoxia. This kind of hypoxia can also result from shock. An example of this might be when the heart fails to pump blood effectively or when there is a constricted artery. During flight, stagnant hypoxia can occur when pulling excessive positive Gforce (exceeding the force of gravity). Cold temperatures can also reduce circulation and decrease the blood supplied to the extremities.

Histotoxic hypoxia

The inability of the cells to effectively use oxygen is defined as histotoxic hypoxia. Histo means tissue or cells, while toxic means poison. In this case, oxygen is being transported to the cells that need it, but they are unable to use it due to the oxygen being contaminated by drugs, tobacco, or alcohol.

(REDLINE) The impairment of cellular respiration (taking oxygen in and moving carbon dioxide out) can be caused by alcohol and other drugs, such as narcotics and poisons. Research has shown that drinking one ounce of alcohol can equate to about an additional 2,000 feet of "physiological" altitude. It should be noted that tobacco that is chewed, tobacco that is smoked, and various narcotics, including prescription pain medications, can impair the cellular respiration process.

Symptoms of hypoxia

High altitude flying can place a pilot in danger of becoming hypoxic. Oxygen starvation causes the brain and other vital organs to become impaired. With increased oxygen starvation, the extremities become less responsive and flying skills deteriorate. The symptoms of hypoxia vary with the individual, but the most common symptoms include:

- blue fingernails and lips,
- headache,
- decreased reaction time,
- impaired judgment,
- euphoria,
- drowsiness,
- lightheaded or dizziness,

- tingling in the fingers and toes, and
- numbness.

As hypoxia worsens, the field of vision begins to narrow and instrument interpretation can become difficult. Even with all these symptoms, the effects of hypoxia can cause a pilot to believe that everything is normal. The treatment for hypoxia includes flying at lower altitudes and/or using supplemental oxygen.

Since pilots are susceptible to the effects of oxygen starvation, regardless of physical condition or acclimatization, the FAA requires that pilots flying their aircraft above 12,500 feet for 30 minutes or longer or at 14,000 feet or above during the entire flight must use supplemental oxygen. The amount required is 1 liter of oxygen per minute for every 10,000 feet. For example, at 18,000 feet there should be a flow of 1.8 liters per minute of oxygen available via a standard breathing device. The FAA requires there should be a device attached to each breathing device that visually shows the flow of oxygen.

(REDLINE) When flying at high altitudes, it is important that oxygen be used to avoid the effects of hypoxia. Even when flying at 25,000 feet, without supplemental oxygen, a pilot has less than five minutes to maintain control; make rational, life-saving decisions; and continue a safe flight. As altitude increases above 10,000 feet, the symptoms of hypoxia increase in severity and the time of useful consciousness rapidly decreases.

(Refer back to illustration 3.3 on page 58.)

The issue of medical certification

- Referring to the 8500-8 medical certification test, do you think that having one ounce of alcohol in your bloodstream would affect any of the outcomes of your test?
- Do you think that having tobacco in your bloodstream during the test might affect the results of your medical certificate?
- Do you think that having a drug, such as a medically prescribed pain-killer, might affect the results of your medical certification examination?

Carbon monoxide poisoning

Carbon Monoxide (CO) is a colorless, odorless, and poisonous gas produced by all internal combustion engines.

When breathed into the human body, it can take up to 48 hours

for the body to dispose of the poisonous CO. If the CO poisoning is severe enough, death can result. Aircraft heater and defrost vents may provide CO a passageway into the cockpit and into the cabin. If there is a strong odor of exhaust gases, it should be assumed that CO is present. However, CO may be present in dangerous amounts even if no exhaust odor is detected. Disposable, inexpensive CO detectors are widely available. In the presence of CO, these detectors change color to alert the pilot of the presence of it. Some effects of carbon monoxide poisoning are:

- headache,
- blurred vision,
- dizziness,
- drowsiness, and
- loss of muscle power.

Anytime a pilot smells exhaust odor, or at any time during flight if any of the above symptoms are experienced, immediate, corrective action should be taken. These actions include:

- turning off the heater,
- opening fresh air vents,
- opening one or more windows, and
- going on supplemental oxygen, if available.

(REDLINE) Since CO attaches itself to the hemoglobin in the blood about 200 times more easily than oxygen, carbon monoxide prevents the hemoglobin from carrying oxygen to the cells, resulting in hypemic hypoxia.

Hyperventilation

Carbon dioxide disposal is a part of the normal metabolic process of breathing; but has to remain at a constant level to work properly. When we experience emotional stress, intense fear, pain, or anxiety, our breathing accelerates and the carbon dioxide level is reduced. This causes a problem, called hyperventilation, which can eventually lead to unconsciousness. This is due to the respiratory system's overriding mechanism to regain control of breathing.

Pilots encountering an unexpected stressful situation may unconsciously increase their breathing rate. When flying at higher altitudes, either with or without supplemental oxygen, a pilot may breathe more rapidly than normal and this may lead to hyperventilation.

(REDLINE) Since many of the symptoms of hyperventilation are similar to those of hypoxia, it is important to correctly diagnose the condition. When using supplemental oxygen, a pilot

should check the equipment and flow rate to ensure the symptoms are not hypoxia-related.

Common symptoms related to hyperventilation are:

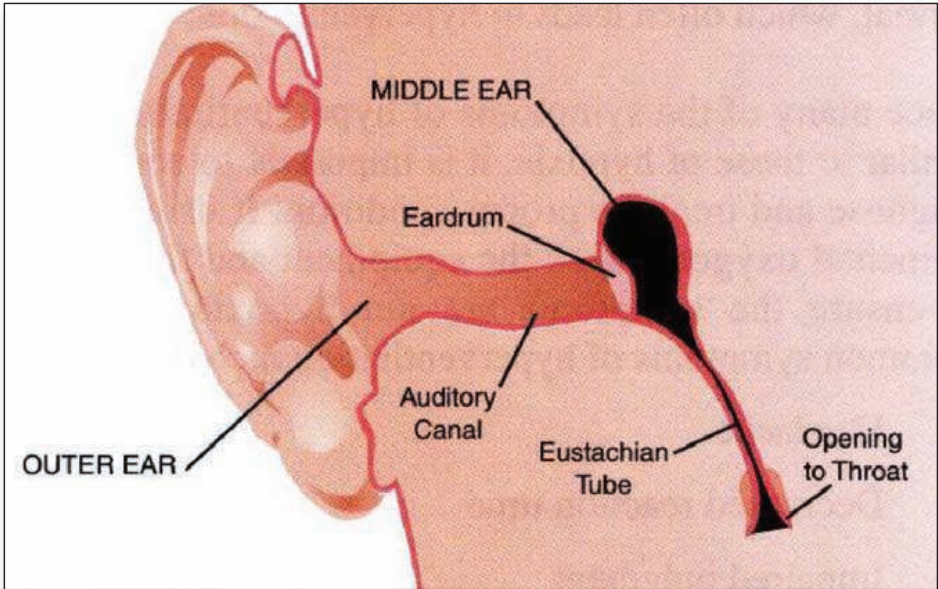
- headache,
- decreased reaction time,
- impaired judgment,
- euphoria,
- visual impairment,
- drowsiness,
- lightheaded or dizzy sensations,
- tingling in the fingers and toes,
- numbness,
- muscle spasms, and
- pale appearance.

The treatment for hyperventilation involves restoring the proper carbon dioxide level in the body. Breathing normally is both the best prevention and the best cure for hyperventilation. In addition to slowing the breathing rate, breathing into a paper bag or talking aloud helps to overcome hyperventilation. Recovery is usually rapid once the breathing rate is returned to normal.

Middle ear and sinus problems

Climbing and descending in an aircraft can sometimes cause ear or sinus pain and a temporary reduction in one's ability to hear. The physiological explanation for this discomfort is a difference between the pressure of the air outside the body and that of the air inside the middle ear and nasal sinuses. Even a slight difference between external pressure and middle ear pressure can cause discomfort. The middle ear is a small cavity located in the bones of the skull. It is closed off from the external ear canal by the eardrum. Normally, pressure differences between the middle ear and the outside world are equalized by the Eustachian tubes which lead from inside each ear to the back of the throat. When these tubes become closed, it can be opened by chewing, yawning, or swallowing, thus equalizing the pressure.

During a climb, middle-ear pressure may exceed the pressure of the air in the external ear canal causing the eardrum to bulge outward. Pilots become aware of the pressure change when they experience alternate sensations of "fullness" and "clearing." During descent, the opposite happens. While the pressure of the air in the



3.8 The Eustachian tube allows air pressure to equalize. (FAA Illustration)

external ear canal increases, the middle ear cavity, equalized with the lower pressure at altitude, is at lower pressure than the external ear canal. This results in higher outside pressure, causing the eardrum to bulge inward.

This condition can be more difficult to relieve due to the fact that the partial vacuum tends to constrict the walls of the Eustachian tube. To remedy this, one can pinch the nostrils shut, close the mouth and lips, and blow slowly and gently in the mouth and nose. This is called the Valsalva maneuver.

The Valsalva maneuver, named after physician Antonio Maria Valsalva, forces air through the Eustachian tube into the middle ear. It may not be possible to equalize the pressure in the ears if a pilot has a cold, an ear infection, or a sore throat. A flight in this condition can be extremely painful, as well as have the possibility of damaging the eardrums. If the pilot is experiencing minor congestion, nasal drops or spray may reduce the chance of a painful ear blockage. Before using a medication, it is advised that the pilot see an aviation medical examiner to ensure that it will not affect his or her ability to fly.

In a similar way, air pressure in the sinuses equalizes with the pressure in the cockpit through a small opening that connects the sinuses to the nasal passages. An upper respiratory infection, such as a cold or sinusitis, or a nasal allergic condition, can produce enough congestion around the small opening to slow equalization. As the differ-

ence in pressure between the sinus and the cockpit increases, congestion may plug the opening. This “sinus block” occurs most frequently during descent. Slow descent rates can reduce the associated pain. A sinus block can occur in the frontal sinuses, located above each eyebrow, or in the maxillary sinuses, located in each upper cheek. It will usually produce excruciating pain of the sinus area. A maxillary sinus block can also make the upper teeth ache. Bloody mucus may even discharge from the nasal passages. If a sinus block does not clear shortly after landing, a physician should be consulted.

A sinus block can be avoided by not flying with an upper respiratory infection or a nasal allergic condition. Adequate protection is usually not provided by decongestant sprays or drops to reduce congestion around the sinus openings. Oral decongestants have side-effects that can impair pilot performance.

Spatial disorientation

Spatial disorientation specifically refers to the lack of orientation with regard to the position, altitude, or movement of the airplane. The body uses three, integrated systems working together to ascertain orientation and movement in space. Visual sensory information from the eye is, by far, the largest source of information. Kinesthesia refers to the sensation of position, movement, and tensions perceived through the nerves, muscles, and tendons, called proprioceptive senses. The vestibular system is a very sensitive motion-sensing system located in the inner ears, reporting head position, orientation, and movement in the three dimensions of flight.

All this information comes together in the brain, and most of the time, the three streams of information agree, giving a clear idea of where and how the body is moving. Flying can sometimes cause these systems to supply conflicting information to the brain which can lead to disorientation. During flight in visual meteorological conditions, the eyes are the major orientation course and usually prevail over false sensations from other sensory systems. When these visual cues are taken away, such as when flying in real IFR (Instrument Flight Rules), false sensations can cause a pilot to quickly become disoriented.

The vestibular system in the inner ear allows the pilot to sense movement and determine orientation in the surrounding environment. In both the left and right inner ears, three semicircular canals

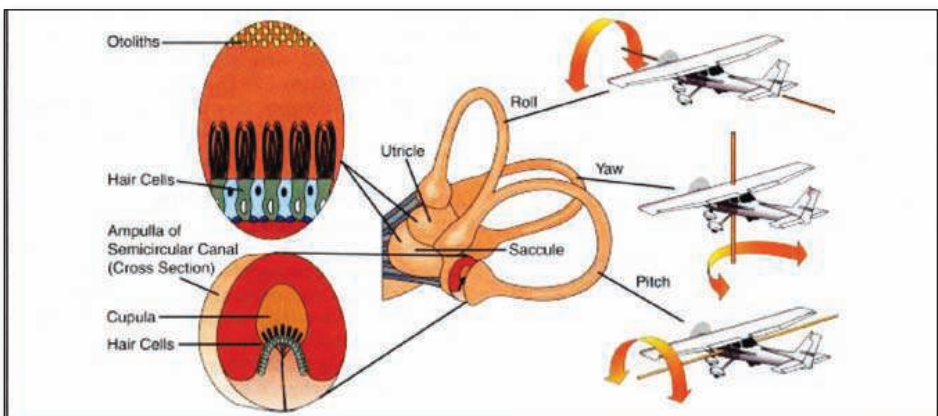
are positioned at approximate right angles to each other. Each canal is filled with fluid and has a section full of fine hairs. Acceleration of the inner ear in any direction causes the tiny hairs to deflect, which, in turn, stimulates nerve impulses, sending messages to the brain. The vestibular nerve transmits the impulses from the utricle, saccule, and semicircular canals to the brain to interpret motion.

They call it “flying by the seat of your pants”

The postural control system coordinates the sensory, skeletal, muscular, and central nervous systems and sends signals to the brain from the skin, joints, and muscles that are interpreted in relation to the earth’s gravitational pull. These signals determine posture. Inputs from each movement update the body’s position to the brain on a constant basis. As in the old expression, “flying by the seat of your pants,” the pilot depends on these signals. Used in conjunction with visual and vestibular clues, these sensations can be fairly reliable; however, the body cannot distinguish between acceleration due to gravity and those resulting from maneuvering the aircraft. This can lead to sensory illusions and false impressions of the airplane’s orientation and movement.

Under normal flight conditions, when there is a visual reference to the horizon and to the ground, the sensory system in the inner ear helps to identify the pitch, roll, and yaw movements of the airplane.

(REDLINE) When visual contact with the horizon is lost, the vestibular system becomes unreliable. Without visual references outside the airplane, there are many situations where combina-



3.9 The semicircular canals lie in three planes and sense the roll, pitch, and yaw motions. (FAA Illustration)



3.10 The ear examination is an important component of the FAA 8500-8 examination. Dr. Sancetta is shown checking the condition of Hannah Schuele's ears.
(Photo by Ben Millspaugh)

tions of normal motions and forces can create convincing illusions that are difficult to overcome. In a classic example, a pilot may believe the airplane is in level flight when, in reality, it is in a gradual turn.

If the airspeed increases, the pilot may experience a postural sensation of a level dive and pull back on the stick, which tightens the turn and creates increasing g-loads. If recovery is not initiated, a steep spiral will develop. This is called the “graveyard spiral” because, if the pilot fails to recognize that the airplane is in a spiral and fails to recover the aircraft to a wings-level flight, the airplane will eventually crash. If the horizon becomes visible again, the pilot will have an opportunity to return the airplane to straight-and-level flight, and continued visual contact with the horizon will allow the pilot to maintain a controlled and sustained flight at the proper attitude.

If contact with the horizon is lost again, the inner ear may fool the pilot into thinking the airplane has started a bank in the other direction causing the graveyard spiral to begin all over again.

(REDLINE) Prevention is usually the best remedy for spatial disorientation. Unless a pilot has many hours of training in the

use of instruments, flight in reduced visibility, or at night when the horizon is not visible, should be avoided altogether. A pilot can reduce susceptibility to disorienting illusions through training and awareness, thus learning to rely totally on flight instruments.

Besides the sensory illusions due to misleading inputs to the vestibular system, a pilot may also encounter various visual illusions during flight. Illusions rank among the most common factors cited as contributing to fatal airplane accidents. Sloping cloud formations, an obscured horizon, a dark scene spread with ground lights and stars, and certain geometric patterns of ground light can create illusions of not being aligned correctly with the actual horizon.

Various surface features and atmospheric conditions encountered in landing can create illusions of being on the wrong approach path. Landing errors from these illusions can be prevented by anticipating them during approaches, inspecting unfamiliar airports before landing, using electronic glide slope or visual approach slope indicator (VASI) systems (lights that help pilots know if they are on the right descent path in final approach and landing) when available, and maintaining a proficiency in landing procedures.

Note: you might want to inquire of your leader about the NASA Barany Chair activity found in the Instructor's Guide for a good disorientation demonstration.

Motion sickness

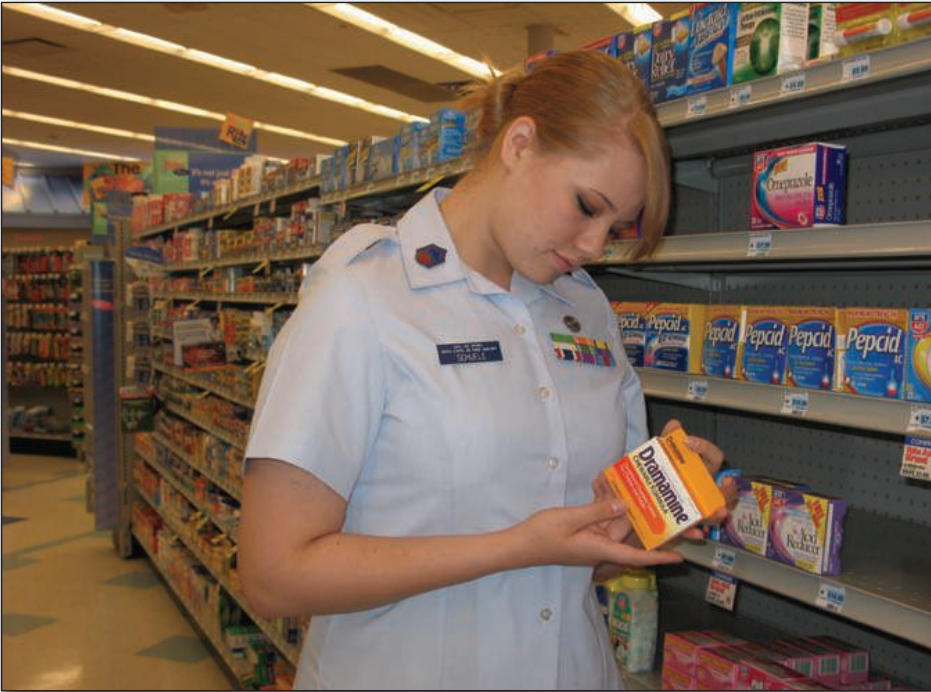
Sometimes called airsickness, motion sickness is caused by the brain receiving conflicting messages about the state of the body. A pilot may experience motion sickness during initial flight training, but this generally goes away within a few more lessons. (Chuck Yeager explained this in his book, *Yeager*, and how he became physically ill on his first ride in an airplane.)

Anxiety, acrophobia, and stress, which may be experienced at the beginning of flight training, can contribute to motion sickness. Motion sickness symptoms are quite well known and include:

- discomfort,
- nausea,
- dizziness,
- pale color,
- sweating, and
- vomiting.

It is important to remember that experiencing airsickness is no reflection on one's natural ability as a pilot. If prone to motion sickness, a pilot-trainee should let the instructor know as there are techniques that can be used to overcome this problem. One way to overcome the problem is to avoid flight-training lessons in turbulent conditions during the early stages of training. Another technique is to start with shorter training flights and then gradually increase the length at a later stage. If motion sickness is experienced during a lesson, instructors have found that opening fresh air vents tends to help decrease the intensity of the symptoms. Other options include having students focus on objects outside of the airplane and make slower head movements.

(REDLINE) Dramamine should not be used since it is known to also cause drowsiness. It is not recommended as a remedy as this medication may impair pilot performance.



3.11 Dramamine is great for passengers, but not pilots. (Photo by Ben Millspaugh)

Tobacco as a source of carbon monoxide

Few people realize that one of the great dangers of smoking is the ingestion of carbon monoxide. Smoking can raise the carbon monoxide concentration in the blood and can result in a physiological effect similar to flying at high altitudes. Besides hypoxia, tobacco is a direct cause of other physiological problems that can medically

affect pilot performance.

Stress

Stress is defined as the body's response to physical and psychological demands placed upon it. The body's reaction to stress includes releasing chemical hormones into the bloodstream (such as adrenaline) and increasing metabolism to provide more energy to the muscles. Stress can cause an increase in:

- blood sugar,
- heart rate,
- respiration,
- blood pressure, and
- perspiration.

An element that causes a person to experience stress is called a "stressor." Examples of this are:

- physical stress, such as noise or vibration,
- physiological stress, such as fatigue, and
- psychological stress, such as difficult work situations, relationship problems (such as personal, family or daily-living interactions), environmental problems, such as traffic, worksite problems, and even spiritual problems (right/wrong decisions based on a belief system).

Stress falls into two broad categories of acute short-term and chronic long-term stress.

(REDLINE) Acute stress involves an immediate threat that is perceived as danger and triggers the "fight or flight" response in an individual, whether the threat is real or imagined. Normally, a healthy person can cope with acute stress and prevent stress "overload." However, on-going acute stress can develop into chronic stress.

Chronic stress can be defined as a level of stress that presents an intolerable burden, exceeds the ability of an individual to cope, and causes individual performance to fall sharply. Unrelenting pressures, such as loneliness, financial worries, relationships, and psychological problems can produce a cumulative level of stress that exceeds a person's ability to cope with the situation. When stress reaches these levels, performance falls off rapidly. Pilots experiencing this level of stress are not safe and should not be flying. Pilots who suspect they are suffering from chronic stress should consult a physician.

Fatigue

Fatigue is an expected aspect of life. Causes of fatigue can range from boredom to circadian rhythm disruption to heavy physical exertion. In lay terms, fatigue can simply be defined as weariness. For the average individual, fatigue presents a minor inconvenience, usually resolved by rest; however, if that person is involved in safety-related activities, such as operating a motor vehicle or piloting an aircraft, the consequences of fatigue can be disastrous.

By definition, fatigue is a condition characterized by increased discomfort with lessened capacity for work, reduced efficiency of accomplishment, loss of power or capacity to respond to stimulation, and is usually accompanied by a feeling of weariness and tiredness.

Obtaining adequate sleep is the best way to prevent or resolve fatigue. Sleep provides the body with a period of rest and recuperation. Insufficient sleep will result in significant physical and psychological problems. On average, a healthy adult does best with eight hours of uninterrupted sleep; however, significant personal variations do occur. A variety of conditions can influence the quality and duration



3.12 These are a few of the incredibly popular energy drinks (Photo by Ben Millspaugh)

of sleep patterns. Some examples are sleep apnea, restless leg syndrome, certain medications, depression, stress, insomnia, and chronic pain.

Some of today's more common social or behavioral issues that affect sleep are late-night activities, excessive alcohol or caffeine use, travel, interpersonal strife, uncomfortable or unfamiliar surroundings (like a temporary worksite, trailer, RV, or hotel room), and shift work.

Consider the possible risks in energy drinks

No one is immune to fatigue. Yet in our society there seems to be a mindset that says, "Take something that will get you going," a pill, a drink, or whatever. This is evident in the incredible rise in the popularity and consumption of energy drinks. There is a large percentage of the world population now consuming energy drinks on a regular basis. Students, construction workers, nine-to-five people in the everyday business world, truck drivers, and, yes, even pilots get a short-term "buzz" from drinking energy drinks. Some of the ingredients in one popular brand are:

- 330 calories,
- 240 mg of sodium,
- 85 grams of sugar,
- 144 mg of caffeine,
- 1 gram of protein,
- carbonated water,
- high fructose corn syrup,
- citric acid,
- 792 mg taurine,
- sodium citrate,
- 266 mg ginseng extract,
- acacia,
- 43 mg carnitine fumarate,
- glycerol ester of wood rosin,
- niacinamide,
- vitamin B6,
- vitamin B12,
- niacin, and
- 2 mg guarana.

Before using such products, research the internet regarding unfamiliar ingredients to ensure no adverse health problems are associ-

ated with ingestion. Instead of “immediate and short-term fixes,” such as energy drinks, one should consider other options, such as exercise, adequate sleep, and healthy foods.

Tobacco and cigarettes

In the past, it was very common for flight crews to smoke cigarettes. A smoke break during a flight was something pilots looked forward to for a few moments of pleasure. Years later, it was found that smoking was very harmful to one’s health and it was eventually linked to cancer. Researchers also found that smoking added more than 1000 feet of “altitude” to the human oxygen/carbon dioxide respiration cycle. That means that when one is smoking and flying at 10,000 feet, the body is physiologically operating at 11,000 or 12,000 feet. Smoking has put the person in the danger zone, and there is a possibility that he/she may start to experience the symptoms of hypoxia. As stated earlier, hypoxia directly affects pilot performance.

In the first six decades of the 20th century, smoking was very common and often encouraged in society. Everyone thought that it was a harmless habit that was part of our way of life. Finally, in the 80s and 90s, more and more evidence was found that linked tobacco to serious health issues and the truth eventually caused smoking to be banned on all forms of transportation, in restaurants, and in businesses.

Dehydration

Dehydration is the term given to a critical loss of water from the body. The first noticeable effect of dehydration is fatigue, which, in turn, makes top physical and mental performance difficult, if not impossible. As a pilot, flying for long periods of time in hot, summer temperatures or at high altitudes increases the susceptibility of dehydration. The dry air at higher altitudes tends to increase the rate of water loss from the body. If this fluid is not replaced, fatigue can progress to dizziness, weakness, nausea, tingling of hands and feet, abdominal cramps, and extreme thirst.

Heat stroke

To prevent heat stroke, it is recommended that an ample supply of water be carried and consumed at frequent intervals on any long flight whether you are thirsty or not. If the airplane has a canopy or

roof window, wearing light-colored, porous clothing and a hat will help provide protection from the sun. Keeping the cockpit well ventilated helps to dissipate excessive heat.

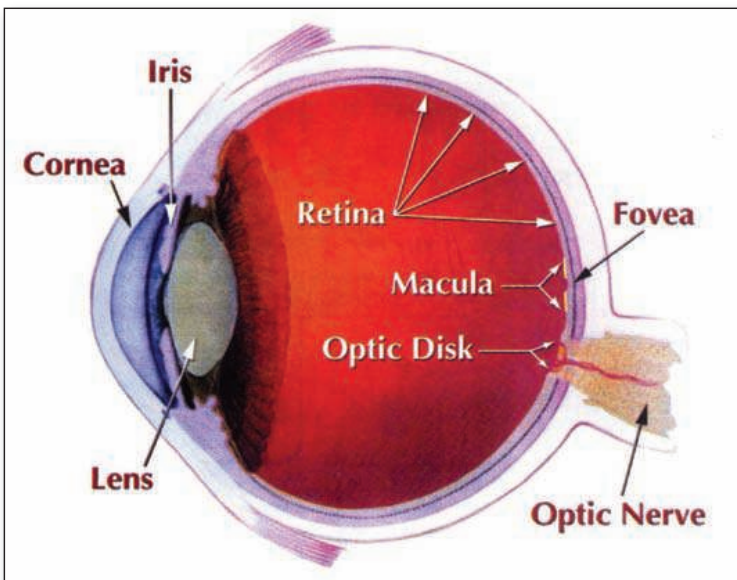
Pilot vision

Vision is a pilot's most important sense to obtain reference information needed during flight. Most pilots are familiar with the optical aspects of the eye. Even before pilots climb into the cockpit, they know if they have normal, uncorrected vision, whether they are farsighted or nearsighted, or if they have other visual problems. Most pilots who have prescription lenses, such as contacts or eyeglasses, have learned to carry an extra set of glasses or contacts with them when flying, just as a backup.

Vision in flight is far more than a lesson in basic optics. Seeing involves the transmission of light energy (images) from the exterior surface of the cornea to the interior surface of the retina (inside the eye) and the transference of these signals to the brain. With that in mind, let's take a look at the anatomy (components) of this wonderful mechanism of vision.

The eye and how it works

Light bounces off an object, enters the eye through the cornea, and then continues through the pupil. The dilation and constriction of the pupil is controlled by the iris, the colored part of the eye. The



3.13 This is a cutaway view of the human eye. (Image courtesy of the FAA)

function of the pupil is similar to the diaphragm of a camera; i.e., it controls the amount of light. The lens is located behind the pupil and its function is to focus light on the surface of the retina. The retina is the inner layer of the eyeball that contains photosensitive cells called the rods and cones. The retina records the image much like a memory card or a roll of film.

The cones are located in higher concentration than rods in the central area of the retina known as the macula that measures approximately 4.5 mm in diameter. The exact center of the macula has a very small depression called the fovea that contains cones only. The cones are used for fine detail and color in high-intensity light vision. They are involved with central vision to detect detail, perceive color, and identify far-away objects.

The rods are located mainly in the periphery of the retina — an area that is about 10,000 times more sensitive to light than the fovea. Rods are used for low-light intensity or night vision and are involved with peripheral vision to detect position references including objects in shades of gray but cannot be used to detect details or to perceive color. Light energy enters the eyes and is transformed by the cones and rods into electrical signals that are carried by the optic nerve to the posterior area of the brain (occipital lobes). This part of



3.14 The cones of the eyes allow us to see and appreciate all of the beauty of a sunrise at 35,000 feet. (Image courtesy of Adam Wright)

the brain interprets the electrical signals and creates a mental image of the actual object by the person.

The cones are responsible for all color vision from appreciating a glorious sunrise to discerning the subtle shades in a fine painting. Cones are present throughout the retina but are concentrated toward the center of the field of vision at the back of the retina. There is a small pit called the fovea where almost all the light sensing cells are cones. This is the area where most “looking” occurs (the center of the visual field where detail, color sensitivity, and resolution are highest).

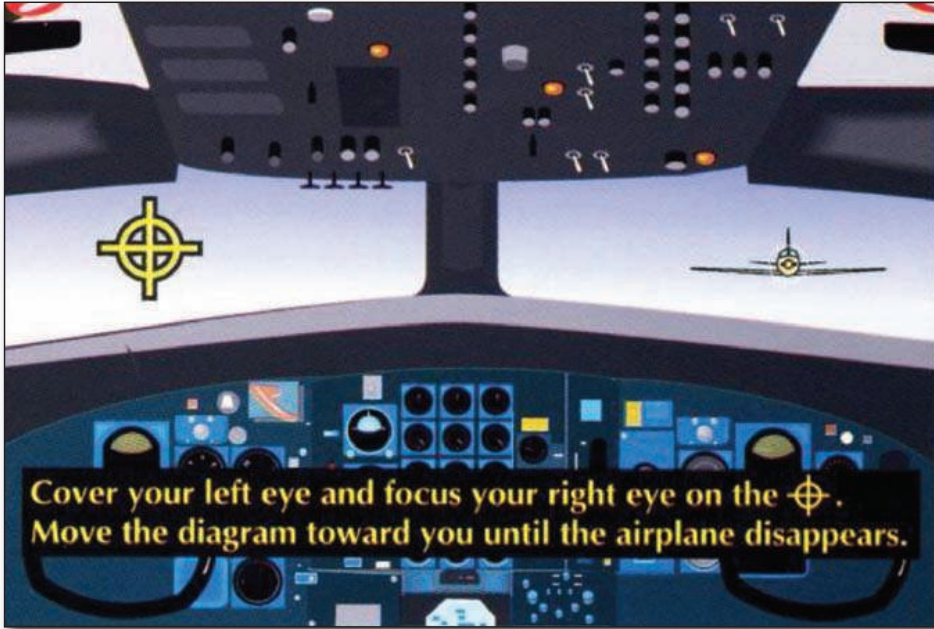
While the cones and their associated nerves are well-suited to detecting fine detail and color in high-light levels, the rods are better able to detect movement and provide vision in dim light. The rods are unable to discern color but are very sensitive in low-light levels. When a large amount of light overwhelms them they take a long time to “reset” and adapt to the dark again. There are so many cones in the fovea that the very center of the visual field hardly has any rods at all. As a result, in low light, the middle of the visual field isn’t very sensitive; however, farther from the fovea, the rods are more numerous and provide the major portion of night vision.

The anatomical blind spot

The area where the optic nerve connects to the retina in the back of each eye is known as the optic disk. There is a total absence of cones and rods in this area, and, consequently, each eye is completely blind in this spot. Under normal binocular (relating to the use of both eyes) vision, this is not a problem because an object cannot be in the blind spot of both eyes at the same time. On the other hand, where the field of vision of one eye is obstructed by something, such as a windshield post, or a visual target, like another aircraft, the item could fall into the blind spot of the other eye and remain undetected.

Night vision

It is estimated that once fully adapted to darkness, the rods are 10,000 times more sensitive to light than the cones, making them the primary receptors for night vision. Since the cones are concentrated near the fovea, the rods are also responsible for much of the peripheral vision. The concentration of cones in the fovea can make a



3.15 By focusing on the “gun-sight” with your left eye covered, the aircraft on the right will eventually disappear as you move closer to the image. (FAA illustration)

night blind spot in the center of the field of vision. To see an object clearly at night, the pilot must expose the rods to the image. This can be done by looking 5° to 10° off of the center of the object to be seen. To understand this concept, in dim light in a darkened room, look directly at an object, and it will dim or disappear altogether. When looking slightly off of center, it will become clearer and brighter because the image is focused mainly on the fovea where detail is best seen. At night, the ability to see an object in the center of the visual field is reduced as the cones lose much of their visual acuity and the rods become more sensitive. Looking off center can help compensate for this night blind spot. Along with the loss of sharpness and color at night, depth perception and judgment of size may be lost.

While the cones adapt rapidly to changes in light intensities, the rods take much longer. Walking from bright sunlight into a dark movie theater is an example of this “dark adaptation period” experience. The rods can take approximately 30 minutes to fully adapt to the dark. A bright light, however, can completely destroy night adaptation, leaving night vision severely compromised while the adaptation process is repeated.



3.16 The night blind spot is approximately 5-10° in the central vision. (FAA Illustration)

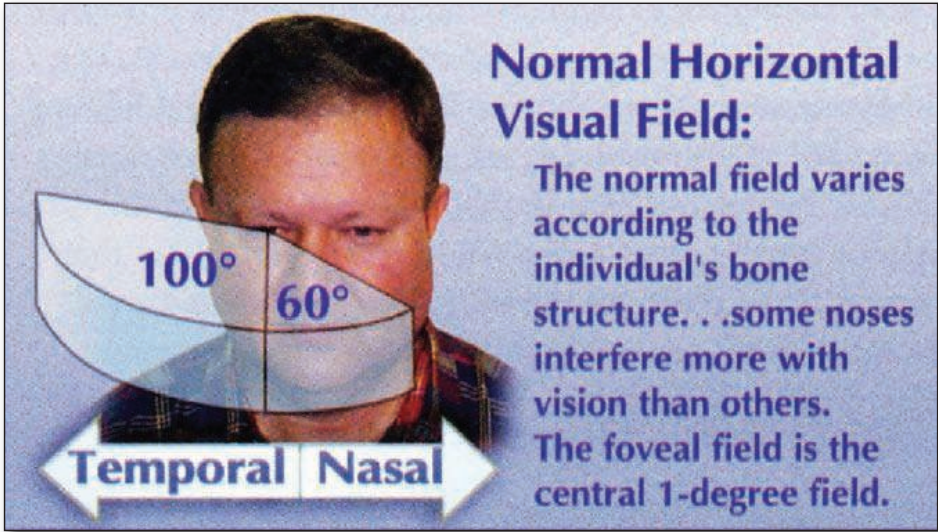
(REDLINE) Several things can be done to keep the eyes adapted to the dark. The first is obvious: avoid bright lights before and during the flight. For 30 minutes before a night flight, avoid any bright light sources, such as headlights, landing lights, strobe lights, or flashlights. If a bright light is encountered, close one eye to keep it light sensitive. This allows the use of that eye to see once the light is gone.

Red cockpit lighting also helps to preserve night vision, but red light severely distorts some color and completely washes out the color red. This makes reading an aeronautical chart difficult. A white light or a carefully directed flashlight can enhance night reading ability. While flying at night, keep the instrument panel and interior lights turned up no higher than necessary. This helps to see outside references more easily. If the eyes become blurry, blinking more frequently often helps.

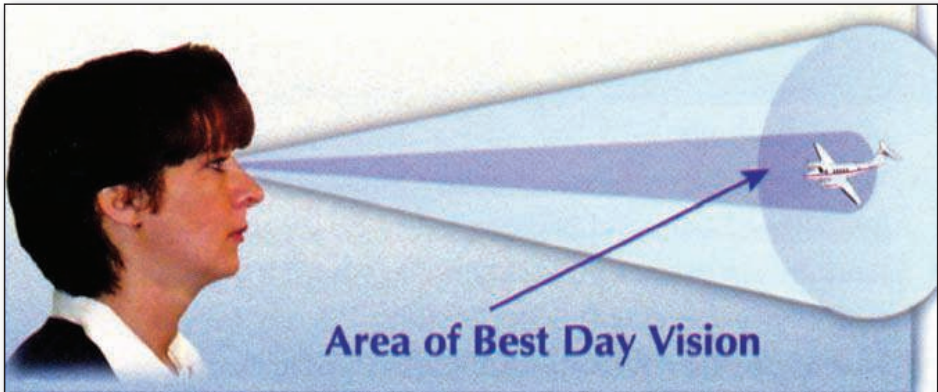
(REDLINE) Diet and general physical health have an impact on how a pilot can see in the dark. Deficiencies in vitamins A and C have been shown to reduce night acuity. Other factors, such as carbon monoxide poisoning, smoking, alcohol, certain drugs, and a lack of oxygen also can greatly decrease night vision.

Types of vision

- **Photopic Vision** - During daytime or high-intensity artificial illumination of conditions, the eyes rely on central vision (foveal cones) to perceive and interpret sharp images and the color of objects.



3.17 This illustration shows the Normal Horizontal Visual Field. (FAA Illustration)



3.18 This illustration shows the Area of Best Day Vision. (FAA Illustration)

- **Mesopic Vision** - Occurs at dawn, dusk, or under full moonlight levels and is characterized by decreasing visual acuity and color vision. Under these conditions, a combination of central (foveal cones) and peripheral (rods) vision is required to maintain appropriate visual performance.
- **Scotopic Vision** – During nighttime, partial moonlight, or low intensity artificial illumination conditions, central vision (foveal cones) becomes ineffective to maintain visual acuity and color perception. Under these conditions, if you look directly at an object for more than a few seconds, the image of the object fades away completely (night blind spot). Peripheral vision (off-center scanning) provides the only means of seeing very dim objects in the dark.

Other factors affecting vision

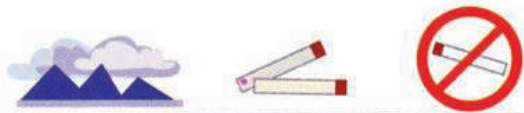
- The greater the object size, ambient illumination, contrast, viewing time, and atmospheric clarity, the better the visibility is of such an object.
 - During the day, objectives can be identified easier at a greater distance with good detail resolution; however, at night, the identification range of dim objects is limited and the detail resolution is poor.
 - Surface references on the horizon may become obscured by smoke, fog, smog, haze, dust, ice particles, or other phenomena, although visibility may be above minimums of visual flight rules (VFR). This is especially true at airports located adjacent to large bodies of water or sparsely populated areas where few, if any, surface references are available. Lack of a horizon or surface reference is common on over-water flights, night flights, and in low-visibility conditions.
 - Excessive ambient illumination, especially from light reflected off of the canopy, surfaces inside the aircraft, clouds, water, snow, and desert terrain can produce glare that may cause uncomfortable squinting, eye tearing, and even temporary blindness.
 - Presence of uncorrected, refractive eye disorders, such as myopia (nearsightedness – impaired focusing of near objects), astigmatism (farsightedness – impaired focusing of objects in different meridians), or presbyopia (age-related impaired focusing of near objects) can significantly affect clear visual acuity.
- (REDLINE) Self-imposed stresses, such as self-medication, alcohol consumption (including hangover effects), tobacco use, withdrawal symptoms, hypoglycemia, sleep deprivation, and fatigue can all impair vision.**
- In-flight exposure to low, barometric pressure without the use of supplemental oxygen (above 10,000 feet during the day and 5000 feet at night) can result in hypoxia, which can impair visual performance.

Other less-known factors can have an adverse effect on visual performance. These include:

- windscreen haze,
- improper illumination of the cockpit,
- improper illumination of the instruments,

- scratched or dirty instruments,
- inadequate cockpit control of temperature and humidity,
- inappropriate sunglasses,
- inappropriate prescription glasses and/or contact lenses, and
- sustained, visual workload.

3.19 This illustration shows the comparison of the reduction in night vision at varying altitudes between non-smokers and smokers. (FAA illustration)



Altitude (ft)	Smokers (% Reduction)	Non-Smokers (% Reduction)
4,000	20	0
6,000	25	5
10,000	40	20
14,000	55	35
16,000	60	40

Focusing

The natural ability to focus your eyes is critical to flight safety. It is important to know that normal eyes may require several seconds to refocus when switching views between near and distant objects. Distance focus, without a specific object to look at, tends to diminish rather quickly. If you fly over water or under hazy conditions with the horizon obscured or between cloud layers at night, your distance focus relaxes after about 60-80 seconds. If there is nothing specific on which to focus, your eyes revert to a relaxed, intermediate focal distance (10-30 feet). This means that you are looking, without actually seeing anything, which is dangerous. To correct this, you must condition your eyes for distant vision. Focus on the most distant object that you can see, even if it's just a wing tip. Do this before you begin to scan the sky in front of you. As you scan, make sure you repeat this refocusing exercise often.

Fatigue can lead to impaired, visual focusing which causes the eyes to overshoot or undershoot the target. Fatigue can also affect a pilot's ability to quickly change focus between near, intermediate, and distant vision. The most common symptoms of visual fatigue include blurred vision, excessive tearing, heavy eyelid sensations, frontal and orbital headaches, and burning, scratchy, or dry eye sensations.

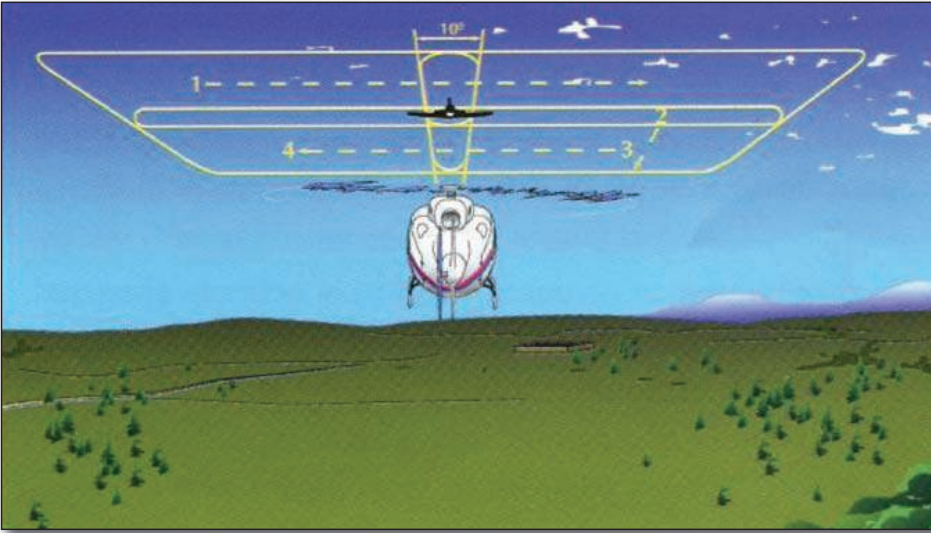


3.20 Not even the passengers in first class get this magnificent view that a pilot sees.
(Image by Adam Wright)

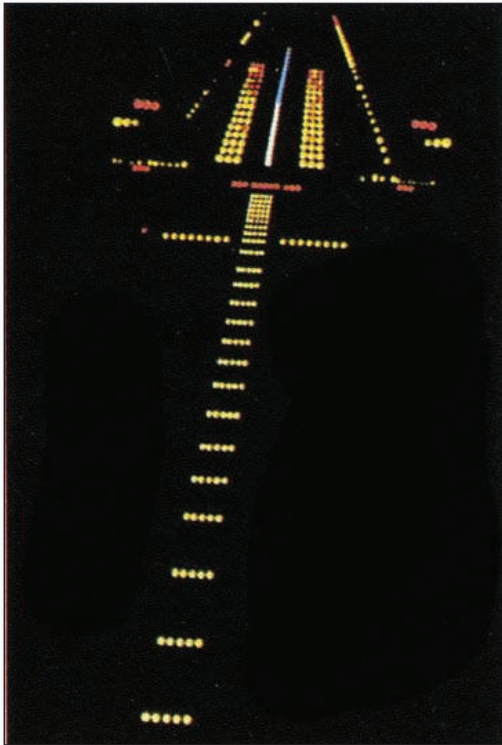
Scanning — see and be seen

Scanning the sky for other aircraft is a very important factor in avoiding midair collisions. The pilot should scan all areas of the sky visible from the cockpit. Most pilots are instinctively alert for potential head-on encounters with another aircraft. Surprisingly, a study of 50 midair collisions revealed that only 8% were actually head-on; 42% were collisions between aircraft going in the same direction. So, compared with opposite-direction traffic, chances of having a midair collision are five times greater with an aircraft you are over-taking or one that is overtaking you.

It is necessary to develop and practice a technique that allows the efficient scanning of the surrounding airspace and the monitoring of cockpit instrumentation, as well. This is accomplished by performing a series of short, regularly spaced eye movements that bring successive areas of the sky into the central (foveal) visual field. Begin scanning at the top of the visual field in front of you and then move your eyes inward toward the bottom. Use a stop-turn-stop type of eye motion. The duration of each stop should be at least 1 second, but not longer than 2-3 seconds.



3.21 To see and identify objects under conditions of low, ambient illumination, avoid looking directly at an object for more than 2-3 seconds. Instead, use the off-center viewing that consists of searching movements of the eyes to locate an object. (FAA Illustration)



3.22 Night vision adaptation is considerably different than performing the same task under full, daylight conditions. (FAA Illustration)

Contact lenses

Use of contact lenses has been permitted to satisfy the distant, visual acuity requirements for pilots since 1976.

Mono vision contact lenses are not acceptable by the FAA. This is because the procedure makes the pilot alternate his/her vision; that is, a person uses one eye at a time, suppressing the other, which consequently impairs binocular vision and depth perception. Since this is not a permanent condition for either eye in such persons, there is no adaptation such as that which occurs with permanent monocular vision. Mono vision lenses, therefore, should not be used by pilots while flying an aircraft.



3.23 *The legendary, World War II Ray-Ban sunglasses created a “look” that is still in fashion 70 years later as aviator sunglasses.*
(Photo by Ben Millspaugh)

Aviator sunglasses – protecting a pilot’s eyesight

Although sunglasses are rarely considered to be an over-the-counter concern, there is a sense that they can be. The general public tends to buy sunglasses for cosmetic reasons rather than for eye protection. It is not at all uncommon to find sunglasses on sale in a drugstore for as little as \$9.95 and the optical quality can be very poor. “Shades,” as they are often called, help safeguard a pilot’s most important sensory asset—vision. A quality pair of sunglasses is essential in the cockpit environment to optimize visual performance. Sunglasses reduce the effects of harsh sunlight, decrease eye fatigue, and protect ocular tissues from exposure to harmful solar radiation. Additionally, they protect the pilot’s eyes from impact of flying debris from a bird strike, sudden decompression, or aerobatic maneuvers. Sunglasses can also aid the dark adaptation process, which is delayed by prolonged exposure to bright sunlight.

Radiation can be both good and bad

Radiation from the sun can damage skin and eyes when exposure is excessive or too intense. Fortunately, the earth’s atmosphere shelters us from the more hazardous solar radiation which includes gamma and x-rays. Both infrared and ultraviolet (UV) radiation are

present in our environment in varying amounts, dependent upon factors such as the time of day and year, latitude, altitude, weather conditions, and the reflectivity of surrounding surfaces (such as the flight line or tarmac). One disturbing fact is that UV radiation increases by approximately 5% for every 1000 feet of altitude.

Atmospheric infrared energy consists of long wavelength radiation (780 to 1400 nanometers). The warmth felt from the sun is provided by infrared radiation and is thought to be harmless to the skin and eyes at normal atmospheric exposure levels. More hazardous to human tissues is short-wavelength UV radiation. UV is divided into three bandwidths: UVA (400-315 nm), UVB (315-280 nm) and UVC (<280 nm). Excessive or chronic exposure to UVA and, to a greater extent, UVB, can cause sunburn and skin cancers, and is implicated in the formation of cataracts, macular degeneration, and other eye maladies. The American Optometric Association recommends wearing sunglasses that incorporate 99-100% UVA and UVB protection. Fortunately, UVC, the most harmful form of UV radiation, is absorbed by the atmosphere's ozone layer before it reaches the earth's surface. Some scientists believe, however, that depletion of the ozone layer may allow more UV radiation to pass through the atmosphere making 100% UV protection a wise choice when selecting eyewear.

Sunglass science

The three most common lens materials in use today are optical quality "crown glass," monomer plastic (CR-39), and polycarbonate plastic. Lenses made from crown glass provide excellent optical properties. Crown glass is, however, heavier and impact-resistant. Glass absorbs some UV light, but absorption is improved by adding certain chemicals during the manufacturing process or by applying a special coating. Glass retains color tints best over a long period of time; however, for higher refractive correction, the color may be less uniform, as parts of the lens will be thicker than others.

CR-39 plastic lenses possess excellent optical quality. They are lighter and impact-resistant. CR-39 lenses tint easily. This type of plastic can be retinted by bleaching it and then repeating the original process.

Polycarbonate plastic lenses are lighter than CR-39 and are, by far, the most impact-resistant. The application of an antireflective coating can improve optical quality, particularly when a highly refractive correction is required. These lenses have built-in UV protection

3.24 *The Serengeti™ Driver™ aviator sunglasses are popular with professional pilots. (Photo by Ben Millspaugh)*



and are manufactured with a scratch-resistant coating that is much stronger than coatings applied to the CR-39 lenses.

Coatings

Special coatings can be applied to lens materials for various protection needs. Crown glass and most plastic lenses require a specific coating to block residual UV radiation. Plastic and polycarbonate lenses require a scratch-resistant coating to prolong their useful life. The scratch-resistant coating applied to polycarbonate lenses also absorbs tints and dyes. While anti-reflective (AR) coatings can improve optical clarity, they are extremely porous, attracting water and oils, making the lenses difficult to clean. Lenses with AR coatings can be sealed with a smudge and water-repellant coat that extends the useful life of the AR coating and makes the lenses easier to keep clean. Coatings must be applied correctly and lenses must be meticulously cleaned for the process to be successful. Coated lenses should be handled with care and not subjected to excessive heat to avoid delamination (mode of failure of composite materials) or crazing (cracks in the surface).

Tints

The choice of tints for sunglasses is practically infinite. The three most common tints are green, gray-green, and brown. Green is a

neutral density filter and is recommended because it distorts color the least. Some pilots, however, report that gray-green and brown tints enhance vividness and minimize scattered (blue and violet) light, thus enhancing contrast in hazy conditions. Yellow, amber, and orange tints eliminate short-wavelength light reaching the wearer's eyes and reportedly sharpen vision, although no scientific studies support this claim. In addition, these tints are known to distort colors, making it difficult to distinguish the color of navigation lights, signals, color-coded maps, and instrument displays. For flying, sunglass lenses should screen out only 70-85% of visible light. Tints that block more than 85% of visible light are not recommended for flying due to the possibility of reduced visual acuity, resulting in difficulty seeing instruments and written material inside the cockpit.

Polarized sunglasses not recommended

Although very popular for most outdoor sports, polarized lenses are not recommended for use in the aviation environment. While useful for blocking reflected light from horizontal surfaces, such as water or snow, polarization can reduce or eliminate the visibility of instruments that incorporate antiglare filters. Polarized lenses may also interfere with visibility through an aircraft windscreen by enhancing striations (ridges) in laminated materials. They can mask the sparkle of light that reflects off shiny surfaces, such as another aircraft's wing or windscreen. This can reduce the time a pilot has to react in a "see-and-avoid" traffic situation.

Photochromic

Glass, photochromic lenses, such as PhotoGray and PhotoBrown, and their plastic counterparts, Transitions, automatically darken when exposed to UV and become lighter in dim light. Most of the darkening takes place in the first 60 seconds, while lightening may take several minutes. Most photochromic lenses can get as dark as regular sunglasses, with 20% light transmittance in direct sunlight. Warm temperatures can seriously limit their ability to darken and reduced UV exposure in a cockpit can further limit effectiveness. In addition, the faded state of photochromic glass lenses may not be clear enough to be useful when flying in cloud cover, or, at night.

What about frames?

The selection of sunglass frames is probably more a matter of personal preference than lens material or tint. The frames of an aviator's sunglasses, however, must be functional and not interfere with communication headsets or protective breathing equipment. Frame styles that incorporate small lenses may not be practical since they allow too much visible light and UV radiation to pass around the edges of the frame. A strap is recommended, especially for prescription sunglasses, to prevent them from accidentally becoming dislodged. Pilots should consult with an eyecare specialist for the most effective alternatives currently available, as the technology is constantly changing in materials, designs and manufacturing techniques.



3.25 Captain Von Pinnon wears a quality pair of Bolle™ sunglasses while performing his flight duties aboard the AvantAir Piaggio 180. Note the recommended blue strap that holds his sunglasses in place during flight. (Photo courtesy of Corry Von Pinnon)

PART FOUR

— Not Fit to Fly —

4.1 Hooking up the tow bar on a Civil Air Patrol Cessna.

Compromised performance

As this section begins, be reminded of the airworthy human section and the emphasis placed on the FAA 8500-8 physical examination. This section talks about nonprescription medications in terms of pilot performance and even how some over-the-counter (OTC) medications can have side-effects that could alter the Form 8500-8 results. Many of the medications mentioned in this section have the potential of compromising human performance while that person is acting as pilot-in-command of an airplane in flight.

Pilot performance can be seriously degraded by prescription, non-prescription, and readily available, OTC medications. Many products, such as sedatives, strong pain-relievers, tranquilizers, antidepressants, and cold and flu medications have primary and secondary effects that may significantly impair cognitive functioning, compromise judgment, affect memory alertness, disrupt coordination, diminish vision, and lower the ability to make important calculations.

Other products, such as antihistamines, blood pressure medications, muscle relaxants, agents to control diarrhea, and medications for motion sickness, have side effects that may impair the same critical functions. Any medication that depresses the nervous system can make a pilot more susceptible to hypoxia.



4.2 A pre-flight inspection of a Civil Air Patrol Cessna.

Just as the pilot does a pre-flight safety check on his/her airplane, so should he/she do a pre-flight safety check on his/her physiological ability to fly the plane. No issue, no matter how seemingly insignificant, should be ignored. Each medical substance put in the pilot's body is capable of compromising optimum flight performance.



4.3 *High performance aircraft pilots require the same high performance skills as a race car driver. (Image is courtesy of Alex McMahon)*

Many prescription and OTC medications can affect pilot skills

In today's society, prescription pain medications are widely used and abused. These medications are known, in most cases, to be highly addictive and physicians warn flight crews not to exercise the privilege of flying an aircraft while taking these drugs. Pain medications are grouped into two broad categories: analgesics and anesthetics. Analgesics are drugs that reduce pain while anesthetics are drugs that deaden pain or cause a loss of consciousness. Both can have a negative effect on pilot performance.

Both OTC medications and prescription drugs can be a serious problem

OTC analgesics, such as aspirin, Tylenol (acetaminophen) and Advil (ibuprofen), have few side effects when taken in the correct dosage. However, depending upon the pain problem, an Aviation Medical Examiner (AME) should be consulted, especially if the pain becomes chronic (constant). Flying usually is not restricted when taking OTC pain medications in proper, recommended dosages.

(REDLINE) Flying is always restricted when taking prescription analgesics. This includes:

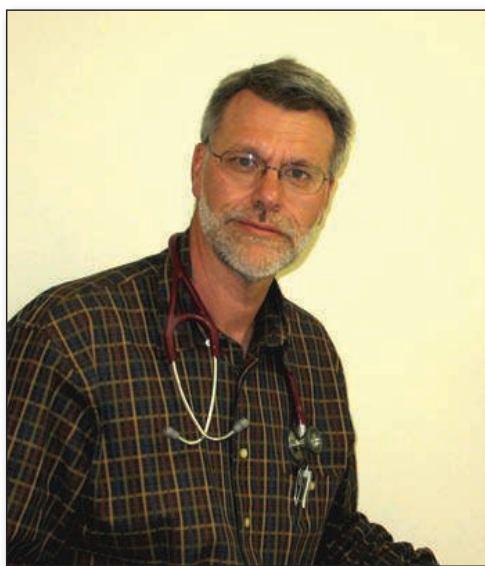
- **Darvon (propoxyphene)**
- **Percocet, Percodan (oxycodone)**
- **Demerol (meperidine)**
- **All medications containing codeine**
- **Morphine-based drugs**

The side effects of prescription pain medications include mental confusion, dizziness, headaches, nausea, vision problems, and the inability to make quick, accurate decisions. Most local anesthetics used for minor dental and outpatient procedures wear off within a relatively short period of time. It is advised that an AME be consulted if the pilot feels that his/her flying skills could have the possibility of being compromised by the medication.

Stimulants are drugs that excite the central nervous system and produce an increase in alertness and activity. Amphetamines, caffeine, and nicotine are all examples of stimulants. Common medical uses of these drugs include appetite suppression, fatigue reduction, and mood elevation. Some of these drugs may cause a stimulant reaction even though this reaction is not their primary function. In some cases, stimulants can produce anxiety and mood swings which are dangerous when flying.

Depressants are drugs that reduce the body's functioning in many areas. These drugs lower blood pressure, reduce mental processing, and slow reaction responses. Several types of drugs can cause a depressing effect on the body such as tranquilizers, motion sickness medications, some stomach medications, decongestants, and antihistamines; however, the most common depressant is alcohol.

Dr. Scott Hompland, noted Denver drug rehabilitation specialist, stated this regarding abuse of drugs:



*4.4 Dr. Scott Hompland, noted Denver anesthesiologist and drug rehabilitation specialist.
(Photo by Ben Millsbaugh)*

“Illegal drugs are no different than prescription medications except for the fact that the dosages are unknown and frequently other problematic additives are involved which make the drug unpredictable in its effect and duration. They both have detrimental effects on an individual’s physical capabilities, reaction time, and visual and auditory abilities. They especially create the effect of altered perception of spatial relations and time.

The secondary side-effects can occur well after the primary effects of the medicine have dissipated and because they are not the primary effect of the medicine, can be easily overlooked. These medications also possess what are referred to as ‘idiosyncratic effects.’ They are unique to the individual and based upon a review of the most relevant medical literature associated with the medicines, are not predictable. Having taken limited flight training, I can now appreciate how even the most innocuous medicine, especially those with potential cognitive impairing abilities, can affect a pilot’s performance without the individual even being aware of the effects until it may be too late.

The effects of alcohol and drugs-of-abuse are always detrimental to one’s ability to perform any action which requires hand-eye coordination, spatial consideration, judgment, and cognition. The long-term effects of these medicines/drugs are unpredictable in terms of who will suffer permanent long-term impairment in the brain and psychological status.”

America’s most serious drug problem — alcohol

Alcohol impairs the efficiency of the human body. Studies have proven that drinking alcohol and performance deterioration are closely linked. Pilots must make hundreds of decisions and some of them are time-critical during the course of a flight. The safe outcome of any flight depends on the ability to make the correct decisions and to take the appropriate actions during routine occurrences, as well as abnormal situations. The influence of alcohol drastically reduces the chances of completing a flight without incident. Even in small amounts, alcohol can impair judgment, decrease the sense of responsibility, affect coordination, constrict visual field, diminish memory, reduce reasoning power, and lower attention span. As little as one ounce of alcohol can decrease the speed and strength of muscular reflexes, lessen the efficiency of eye movements while reading, and increase the frequency of errors.

The alcohol consumed in beer and mixed drinks is ethyl alcohol,

or ethanol, a central nervous system depressant. From a medical point of view, it acts on the body much like a general anesthetic. When drinking alcohol, the anesthetic dose is generally much lower and more slowly consumed, but the basic effects on the human body are similar. Alcohol is easily and quickly absorbed by the digestive tract. The bloodstream absorbs about 80 to 90% of the alcohol in a drink within 30 minutes when ingested on an empty stomach. The body requires about three hours to get rid of all the alcohol contained in one mixed drink or one beer. While experiencing a hangover, a pilot is essentially still under the influence of alcohol. Although a pilot may think he or she is functioning normally, motor and mental response impairment is still present. Considerable amounts of alcohol can remain in the body for over 16 hours. This alone should tell pilots that they should be cautious about flying too soon after drinking.

Altitude multiplies the effects of alcohol on the brain. When combined with altitude, the alcohol from two drinks may have the same effect as three or four drinks. Alcohol interferes with the brain's ability to utilize oxygen, producing a form of histotoxic hypoxia. The effects are rapid because alcohol passes quickly into the bloodstream. In addition, the brain is a highly vascular organ that is immediately sensitive to a change in the blood's composition. For a pilot, the lower oxygen availability at altitude and the lower capability of the brain to use what oxygen is there, add up to a deadly combination.

Intoxication is determined by the amount of alcohol in the bloodstream. This is usually measured as a percentage, by weight, in the blood. The Federal Aviation Regulations (FAR) (14 CFR Part 91) require that a blood alcohol level be less than .04 percent and that 8 hours should pass between drinking alcohol and piloting an airplane. A pilot with a blood alcohol level of .04 percent or greater, even after 8 hours, cannot fly until the blood alcohol level falls below that amount. Even though the blood alcohol may be well below .04 percent, a pilot cannot fly sooner than 8 hours after drinking alcohol. Although the FARs are quite specific, it is recommended by most AMEs that even more time be allowed. Most corporate and airline operations require a minimum of 12 hours between "bottle and throttle."

Alcohol, self medication, and self-imposed stress

In defining self-imposed stress, it is necessary first to define stress. Stress is defined as the sum of the biological reactions to any adverse

stimulus (physical, mental, emotional, internal, or external) that tends to disturb the organism's natural balance. It is difficult to measure the full effect that stress can have, but some of the contributing factors that can increase the amount of stress one is experiencing include: alcohol, drugs, tobacco, diet, fatigue, and disruption of the sleep cycle. In determining the effects of each of these stresses, it is also important to point out how each might affect a pilot's performance.

We are aware of the dangerous side effects that alcohol has on one's driving ability. It's not difficult to figure out that alcohol, in any quantity, can adversely affect flying skills, especially where there is less oxygen and a lower pressure. Once alcohol is in the system, cell metabolism is depressed, especially in the brain. Because cell metabolism in the brain is impaired when drinking, so, also, is the utilization of oxygen that is delivered to the cells of the body.

(REDLINE) Some of the performance issues that may be degraded by the use of alcohol during flight include:

- **judgment,**
- **speed and strength of muscular reflexes,**
- **inhibitions,**
- **insight into existing capabilities,**
- **comprehension,**
- **attention to minute details,**
- **efficiency of eye movements,**
- **ability to see under dim illumination,**
- **hearing,**
- **sense of responsibility,**
- **memory,**
- **reasoning ability, and**
- **altered perception of a situation.**

Since every individual is physiologically different, the symptoms experienced from the ingestion of alcohol will vary in severity and intensity. One reason for this is the rate of alcohol absorption which depends on:

- type and quantity of food in the stomach,
- concentration of alcohol in the beverage,
- the human's bodyweight,
- the degree of dehydration, and
- how fast the alcoholic beverage is consumed.

Another factor is the rate of digestion, or metabolism, of the alcohol. On average, our liver is only capable of clearing approximately



4.5 Everclear grain alcohol is sold as 151 proof or 75.5% alcohol and 190 proof or 95% alcohol, which would be well above an alcohol content to be ingested prior to 8-12 hours for flight. (Photo by Ben Millspaugh)

one-third of an ounce of pure alcohol per hour from the body. To create a better picture of the time it would take to absorb certain types and amounts of alcohol, the following examples give the size and percentage of alcohol in more popular drinks:

Wine	4 oz	12% alcohol
Light Beer	12 oz	4% alcohol
Vodka	1 oz	50% alcohol
Whiskey	1.25 oz	40% alcohol

How much time do you think it would take for the liver to clear each amount noted about?

Blood alcohol concentration and resulting effects

The following shows the progressive effects of blood alcohol concentration on the body:

- 0.01 – 0.05 — Average individual appears normal
- 0.03 – 0.12 — Mild euphoria, talkativeness, decreased inhibitions, decreased attention, impaired judgment and decreased reaction time
- 0.09 – 0.25 — Emotional instability, loss of critical judgment, impairment of memory, impairment of comprehension, decreased sensory response, and mild muscular non-coordination
- 0.18 – 0.30 — Confusion, dizziness, exaggerated emotions, (such as anger, fear, grief), impaired visual perception, decreased pain sensation, impaired balance, staggering walk, slurred speech, and moderate muscular non-coordination
- 0.27 – 0.40 — Apathy, impaired consciousness, stupor, significantly decreased response to stimulation, severe muscular noncoordination, inability to stand or walk, vomiting, and incontinence of urine or feces

- 0.35 – 0.50 — Unconsciousness, depressed or abolished reflexes, abnormal body temperature, and possible death (due mostly to respiratory paralysis)

(REDLINE) It has been shown that each 10,000 feet of altitude doubles the effects of alcohol in the body, thus flying with a high blood alcohol concentration is very dangerous for both pilots and passengers.

More long term subtle effects

There are several chronic (long-term) effects of alcohol, such as a deficiency in vitamins, minerals, and proteins; liver impairment; alcoholic psychosis; and excessive carbohydrate levels.

(REDLINE) The one long-term effect that is most noticeable and poses a serious danger to a pilot or flight crew member is a hangover. Many experts believe that this may be even a greater threat than mild intoxication.

The symptoms of a hangover may not be solely due to alcohol ingestion. Many of the symptoms are due to the activities that accompany drinking. Large amounts of alcohol, along with increased amounts of gastric acid, will irritate the lining of the stomach. Blood vessels in the brain dilate, which is part of the reason for the headache associated with a hangover. Other factors that intensify the hangover symptoms are smoking, loss of sleep, and a poor diet.

An even bigger factor from a hangover is dehydration. This occurs with the loss of fluids from the cells of the central nervous system and from the cerebral spinal fluid that surrounds the brain. This loss of fluid causes tension on the supporting structure of the brain, resulting in a headache. Dehydration can impair judgment and cause emotional changes that may seriously interfere with the pilot's ability to perform effectively. It can also lead to, or compound, the effects of disorientation.

There is a belief that drinking strong coffee or taking a cold shower will help a person sober up more quickly. Is it true? The answer is no. Time, and only time, can make a person sober.

Alcohol kills more young Americans than all other drugs combined

Unfortunately, alcohol is the “recreation drug of choice” for many well-known celebrities, movie idols, music stars, athletes, and

other role models. In the business world, thousands of workers, from all levels, drink alcoholic beverages during and after the workday.

- Over 50% of all American adults consume alcoholic beverages.
- On a per capita basis, the consumption of alcohol is about 25 gallons per person per year.
 - In the United States alone, over 100,000 deaths are caused both directly and indirectly every year by excessive alcohol consumption. This figure includes deaths due to drunk driving and liver failure.
 - More than 50% of adult drinkers said they have a “blood” relative who was an alcoholic or had a drinking problem.
 - Close to 20% of Americans experience alcohol abuse or dependence at some time in their lives.
 - Throughout all age ranges, males are four times more likely to be heavy drinkers as compared to females.
 - Underage drinking costs the United States an estimated \$58,000,000,000 per year in legal and medical expenses.
 - Alcohol kills 6 times more youth than all other illicit drugs combined.
 - Automotive crashes are the greatest single cause of death for Americans between the ages of 6-33. Of this, approximately 45% of the crashes are alcohol-related.

(REDLINE) Despite the tireless efforts of thousands of anti-drug and alcohol advocates and warnings, impaired drivers continue to kill someone every 30 minutes or nearly 50 people a day. That’s 18,000 people per year.

An incredible story about alcohol abuse

Here is a brief synopsis of the *Flying Drunk* book.

March 8, 1990: An intoxicated three-man crew, including Flight Engineer Joseph Balzer, fly a Northwest Airlines Boeing 727 with 91 passengers aboard from Fargo, North Dakota to Minneapolis, Minnesota. Upon arrival in Minneapolis, the crew was arrested.

July 25, 1990: All three pilots stand trial for flying a commercial airliner while under the influence of alcohol; all three are convicted and sent to federal prison.

July 26, 1990 - present: Joe Balzer fights for redemption and to regain all that he has lost. *Flying Drunk* is his story.

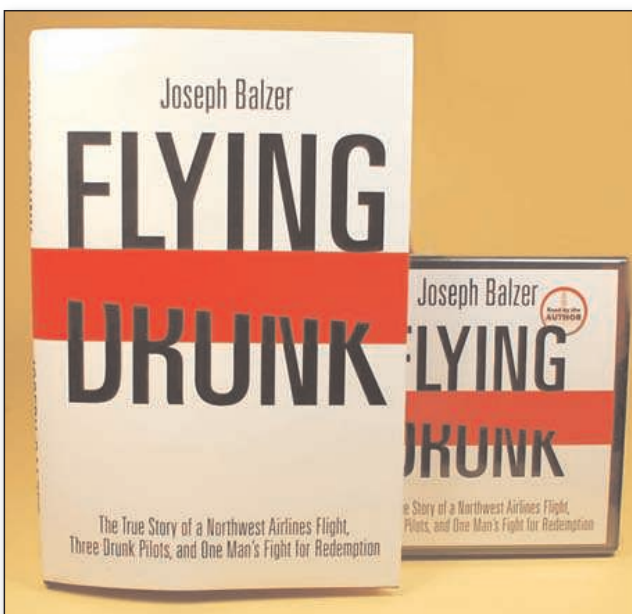
Since he was a young boy, Joe Balzer dreamed of flying. He pursued his goal with a vigorous passion and earned his pilot licenses,

piling up hours of flight time with a wide variety of planes and jets with one overarching goal: to one day fly for a major airline. But Joe had a problem. He was an alcoholic and refused to admit to himself that he had a problem.

His alcoholism caught up with him in March 1990, when Joe was arrested with two other pilots for flying a commercial airliner while under the influence of alcohol. His world began crumbling around him and his new marriage faced the ultimate test. He lost his promising career and his dignity. Every major media outlet, including *The New York Times*, *Newsweek*, and *Time Magazine*, covered the shocking story for the stunned American flying public. The trial that followed drained Joe's life's savings and federal prison nearly broke him. *Flying Drunk* is Joe's bittersweet and thoroughly chilling memoir of his twisted journey to a Federal courtroom, his time in the notorious Federal penitentiary system in Atlanta, Georgia, and his struggle to recapture all that he held dear. Captain Balzer gives credit for his



4.6 Captain Joe Balzer was given a second chance by some great people with American Airlines. (Photo by Ben Millspaugh)



4.7 "Flying Drunk" is the compelling story of an airline pilot who lost everything because of alcohol. He then made a miraculous comeback and is flying again. (Photo by Ben Millspaugh)

recovery, and protection while in prison, to God and the thousands of people who prayed for him during his “darkest hour.”

Today, Joe is a recovering alcoholic, celebrating more than nineteen years of sobriety. The long road back from perdition led him to American Airlines, where some very understanding people and a great organization recognized a talented pilot who had cleaned up his act and was ready to fly again, safely. *Flying Drunk* is the story of an incredible journey of the human spirit, from childhood to near death, and back again.

Weight loss medications and the internet

With obesity reaching near crisis levels in the United States, people are willing to try anything that will help them lose weight, especially those supplements that are marketed as “safe, natural, and inexpensive.” Many varieties of these “natural” weight-loss substances are available from all around the world.

The Food and Drug Administration (FDA) has shown little or no concern about weight-loss substances that do not contain anything proven to be illegal or threatening. These are known as undeclared pharmaceutical ingredients found inside diet pills. Many OTC appetite suppressants contain a substance known as sibutramine, but it is also administered as an oral treatment for obesity and is illegal without a prescription. It is known to elevate blood pressure and heart rate. Scientific evidence also links it to heart attacks and strokes.

The question is, “How does a potentially dangerous substance such as this make its way into a “natural” supplement?” Diet pill manufacturers are often located in other countries where pharmaceutical regulations are not as strict as those found in the United States. Diet pills can be ordered directly online and shipped to customers by mail. For the most part, ordering substances on the Internet goes unnoticed; however, sometimes it does get attention. According to a story featured in the media, a shipment from a foreign Internet pharmacy arrived in Lubbock, Texas on March 17, 2009. The parcel contained 1,830 diet pills, all of which contained sibutramine. The prescription dosage of this substance in the United States is between 15-20 milligrams. In this shipment, pills with as much as 55 milligrams of sibutramine were seized. The foreign diet pills were called Meizitang and dosages as high as those found in this shipment could

cause heart and other vascular problems. The news report said that the buyer was reselling the pills, and that it was not uncommon to find these available at local flea markets. Thus, potential weight loss supplement purchasers need to beware.

Society's quick fix for everything

Unfortunately, we are a society that looks for the “quick fix” for everything, including our body chemistry. If you are a flight crew member and you take any substance, whether it is food, vitamins, OTC medications, or prescriptions, hopefully you know in advance the effect it will have on you and your performance while operating an aircraft. Some people are under the impression that if a drug is safe enough to buy over-the-counter without a prescription, then it must also be safe enough to pilot an aircraft while under its influence.

Statistics show that about 80% of all major aircraft accidents, both military and civilian, usually involved human factors. Since the effects of a particular drug can be intensified with altitude, it is up to the pilot to be aware of the effects of any medication that he or she might consider taking before operating an aircraft. If there is any doubt, the pilot should consult an AME or local pharmacist and ask about the possible side effects of a particular medication, OTC substance, vitamin, or herbal supplement.

Self-medicating with OTC substances presents several risks to pilots and flight crew members. First, OTC medications tend to only mask conditions and make the pilot or crew member unsafe. Second, the results of taking the drug can have undesirable effects on the pilot or crew member's ability to perform their critical tasks. For example, if you were to take an antihistamine for symptoms of a cold, you may experience a temporary relief of the cold symptoms, but these same symptoms, or others, may appear during flight and impair performance.

(REDLINE) The dangers of any drug taken inappropriately are very well documented. Certain drugs can have hallucinatory effects that can occur days or weeks after the drug is taken. They have no place in the cockpit or on the ground.

Prescription medications

When your primary-care physician prescribes a medication for you, ask if he or she knows of any possible side effects that might be an issue when you're flying. If you or your doctor have any questions about your condition, or a prescribed medication, it is best that you contact an AME.

When your pharmacy fills a prescription, let the pharmacist know that you are a pilot. Pharmacists are experts in medication side effects and can often provide advice that supplements the information your physician gives you. The pharmacist will provide you with written information about your medication. You should treat this just like the label of an OTC medication. Read, understand, and follow the instructions that are given with the medication. Never hesitate to discuss possible problems with your physician, pharmacist, or AME.

Also any "maintenance medication," even for mild medical conditions, should be cleared for use by an AME. The reason is that many



4.8 A pharmacist is a specialist in the side effects of drugs. A pharmacist should be consulted if you are taking a medication and if there is a possibility that one or more side effects could be an issue on the 8500-8 medical examination or before flying. (Courtesy of Pharmacist Ed Foster)

of the side effects are unknown and the reaction to the medication varies with the individual. The *Guide for Aviation Medical Examiners* gives excellent guidance about performing flight duties while under a doctor's care or when taking any kind of medications.

Some drugs that are classified as neither stimulants nor depressants can have adverse effects on flying. For example, some antibiotics can produce dangerous side effects such as balance disorders, hearing loss, nausea, and vomiting. While many antibiotics are safe for use while flying, the infection requiring the antibiotic may prohibit flying. In addition, unless specifically prescribed by a physician, it is recommended that pilots do not take more than one drug at a time and never mix drugs with alcohol because the effects are often unpredictable.

It is recommended that pilots consider these points:

- You may develop a medical condition that makes you unsafe to fly. The FAA clearly states that the responsibility for having a safe flight rests directly upon the shoulders of the pilot. As a pilot you may want to wait until the condition is either gone or significantly improved before flying.
- If any medical condition makes you feel uncomfortable, seek the advice of an Aviation Medical Examiner before flying.

Should I take this medication?

Just like any other decision-making process when flying, it is always important to get the facts first and then decide. When it comes to taking medications, prescriptions, or OTC medications, there are several things that you need to know and take under consideration before making a decision. They are:

- First, consider the underlying condition that you are treating. What will be the consequence if the medication doesn't work or if it wears off before the flight is over? A good general rule to follow is not to fly if you must depend on the medication to keep the flight safe.
- Second, you must consider your reaction to the medication. An individual can have a unique reaction based on the individual's biological make-up. Most people don't have such adverse reactions, but some can have unpleasant reactions when given new or different medications. Because of this, you should not fly after taking any medication for the first time. It is not until after you have taken the medication that you will find out whether you have an uncommon or



4.9 Over-the-counter drugs are not tested at high altitudes and side-effects are unknown. What you took “down there” may affect your flying skills “up here.” (Photo by Ben Millsbaugh)

unexpected reaction to the medication. Also, side effects can occur at any time. Even if you’ve taken the same medication in the past without experiencing side effects, they could still occur, especially in a higher altitude and lower pressure environment.

- Third, consider the potential for an adverse reaction. Surprisingly, reactions are quite common and the manufacturer of the medication lists these on the label. You must carefully read all labeling. If you don’t have access to the label, then don’t fly while using the medication.

(REDLINE) Read the label for key words, such as lightheadedness, dizziness, drowsiness, or a visual disturbance. If these side effects are listed, or if the label contains a warning about operating motor vehicles or machinery, then it is recommended you not fly while using this medication.

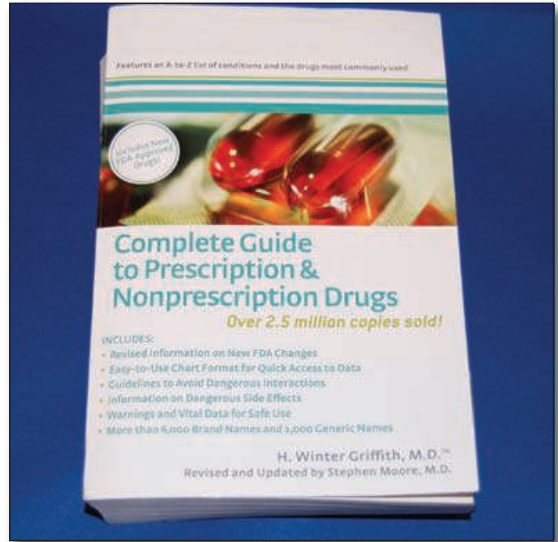
Common side effects of frequently used OTC medications

If you must take OTC medications, read and follow the manufacturer’s label directions. If the label warns of significant side effects, do not fly after taking the medication until at least two dosing intervals have passed. For example, if the directions say that you should take the medication every 6 hours, then wait until at least 12 hours after last dose to fly. Remember that you should not fly if the underlying condition that you are treating would make you unsafe if the medication fails to work. If you have questions or doubts about a

medication, ask your pharmacist first and then an AME.

Ephedrine and pseudoephedrine are OTC drugs with side effects similar to the human hormone adrenalin, also known as epinephrine. Ephedrine, which is available in both prescription and nonprescription strengths, is used to dilate the bronchial tubes in the lungs making it easier for people to breathe. Nonprescription ephedrine, in nose drop and spray forms, is used to relieve nasal congestion due to hay fever and flu. All of the ephedrines are now behind the pharmacy counters for the safety of the public and to limit the supplies and the use as an ingredient in illegal methamphetamines. Common ephedrine side effects include nervousness, anxiety, dizziness, and loss of appetite or sleep. All of these may affect your ability to fly safely.

Chlorpheniramine is an antihistamine used to relieve seasonal allergy symptoms including sneezing, runny nose, itching, and watery eyes. It is also used to treat immediate allergic reactions. Chlorpheniramine is available in nonprescription products alone and in combination with other nonprescription drugs to treat symptoms of allergy, colds, and upper respiratory infections. Chlorpheniramine has many potentially dangerous side effects for pilots. These include confusion, drowsiness, dizziness, blurred vision, and problems with memory and concentration.



4.10 There are numerous books on prescription and nonprescription drugs. One that is a best-seller on the subject was written by H. Winter Griffith, a medical doctor. This book is recommended as a home resource for OTC, nonprescription medications. (Photo by Ben Millsbaugh)



4.11 Most of these medications are now kept behind the counter in the pharmacy. That should be a warning in itself. In the chart below, it gives some of the side effects these medications. (Photo by Ben Millsbaugh)

COLDS/FLU <i>(cont)</i>	DECONGESTANTS Afrin Nasal Spray Sine-Aid Sudafed	Excessive stimulation, dizziness, difficulty with urination palpitations	Aggravate high blood pressure, heart disease, and prostate problems
	COUGH SUPPRESSANTS Benlyn Robitussin CF/DM Vicks Formula 44	Drowsiness, blurred vision, difficulty with urination, upset stomach	Increase sedative effects of other medications
BOWEL PREPARATIONS	LAXATIVES Correctol Ex-Lax	Unexpected bowel activity at altitude, rectal itching	
	ANTI-DIARRHEALS Imodium A-D Pepto-Bismol	Drowsiness, depression, blurred vision (<i>See Aspirin</i>)	
APPETITE SUPPRESSANTS	Acutrim Dexatrim	Excessive stimulation, dizziness, palpitations, headaches	Increase stimulatory effects of decongestants, interfere with high blood pressure medications
SLEEPING AIDS	Nytol Somnex	<i>(Contain antihistamine)</i> Prolonged drowsiness, blurred vision	Cause excessive drowsiness when used with alcohol
STIMULANTS	CAFFEINE Coffee, tea, cola, chocolate	Excessive stimulation, tremors, palpitations, headache	Interfere with high blood pressure medications

4.12 Check these side effects before flying or taking the FAA test!

Meet Jeffrey Cain, MD

Dr. Jeffrey Cain is an avid “grassroots” pilot who flies a Hatz CB1 biplane and a 1946 Aeronca Champ. His motto is “the fun stops at 100 mph.” He was raised in the small town of Sherwood, Oregon and received his doctorate degree at a medical school in Portland, Oregon. He moved to Denver, Colorado for his residency training and now serves as the Chief of Family Medicine at the Children’s



*4.13 Jeffrey J. Cain, MD,
Chief of Family Medicine,
Children's Hospital,
Denver, Colorado
(Photo courtesy of
Jeffery Cain, M.D.)*

Hospital. With a lifelong passion for the historical aspect of flight, Dr. Cain has built and flown huge kite replicas of the works of early aviation pioneers including Chanute, Langley, and Lilienthal. Several of these magnificent kites are on display at the Wings Over the Rockies Aerospace Museum located in Denver.

Attending the Experimental Aircraft Association (EAA) AirVenture Fly-in for the first time lit the fire for him to follow his heroes into flight. After getting his pilot’s certificate, he bought the Hatz CB-1 and flew it to the AirVenture show in Oshkosh, Wisconsin the following year, and since then he has been involved in the Colorado Antique Airplane Association. He has introduced over 500 children to the joys of flight as part of the EAA Young Eagles program and is also a supporter of CAP’s Drug Demand Reduction Program. This doctor lost both legs in an airplane crash. He has an exceptional amount of courage and strength of character.

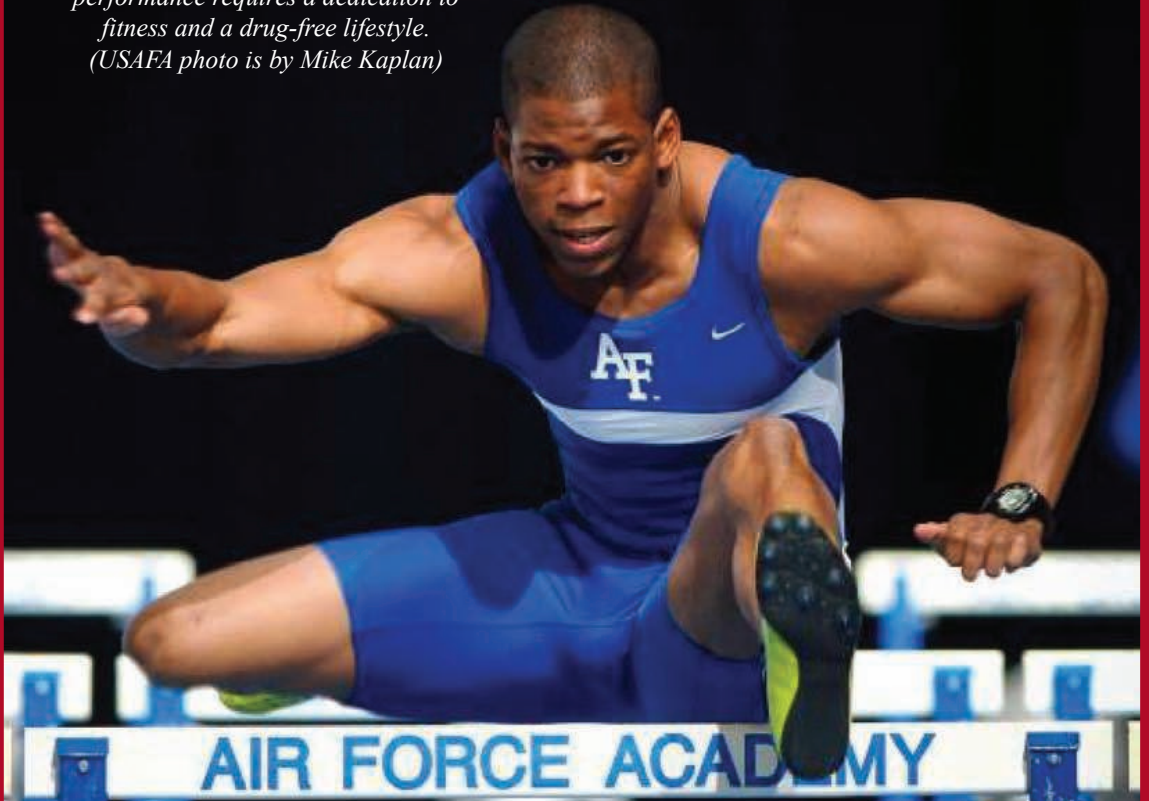


4.14 Although Dr. Cain lost both his legs in a near-fatal airplane crash, he has made an incredible recovery. His passion is for grass-roots aviation and he has flown over 500 children as part of the EAA Youth eagles program in his home built Hatz CB-1 Biplane. (Image by Jon Youngblood)

PART FIVE

— Fitness as a Lifestyle —

*5.1 Air Force Academy Cadet Kellen Curry makes a record-breaking run in a major collegiate competition. Maximum performance requires a dedication to fitness and a drug-free lifestyle.
(USAFA photo is by Mike Kaplan)*



A better life

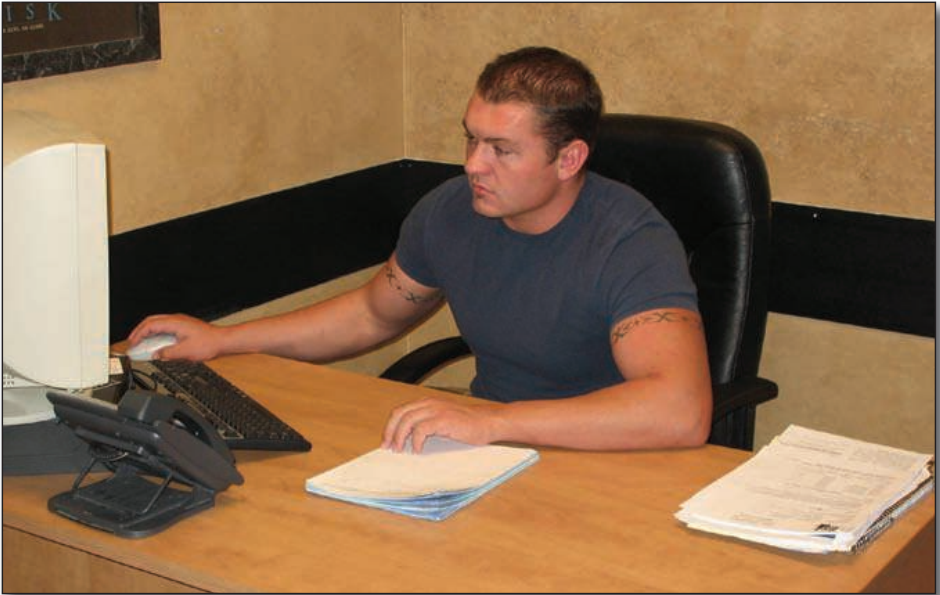
“Use it or lose it!” That old saying not only relates to flying skills; but also applies to maintaining a high-performance human body. Muscles that aren’t used tend to weaken as you get older and it’s a never-ending battle to stay strong and alert. The muscular and the cardiovascular systems must work at optimum levels and this demands that both systems be stimulated and utilized. People who carry too much weight or who are bordering on obesity, often encounter many health-related problems ranging from chronic backaches to advanced cardiovascular disease. Being more physically fit will generally make you look and feel better. Staying in top physical condition is one of the best ways to assure that you will always pass the FAA’s flight physical examination. A high level of personal fitness can also help you to cope with the various emotional and physical stressors that are encountered in the flight environment.

Step one—get a physical

Before starting a physical fitness program, it is highly recommended by the FAA aeromedical physicians that you get a thorough physical examination. Make sure that you tell your family physician



5.2 Many doctors recommended getting a physical examination before starting a physical fitness program. (Photo by Ben Millsbaugh)



5.3 The next step is to get professional guidance. Nationally-recognized fitness expert, Curtis McCoy of Club USA, agreed to help the Dakota Ridge Cadet Squadron with a fitness program that will help them prepare for their glider and flight encampments. McCoy promotes being a drug-free athlete. (Photo by Ben Millsbaugh)

of your intentions to start a fitness program. It is also recommended that, as a pilot, you consult with your AME before starting a fitness program and that you seek the advice of a certified fitness professional who helps athletes achieve maximum results without harmful steroids or other performance-enhancing substances.

A commitment to changing your lifestyle

Always keep in mind that becoming fit requires a lifestyle change. You are going to have to commit to making changes such as; adjusting your diet, eating the appropriate foods with realistic portions, deciding to walk rather than drive, and taking the stairs instead of the elevator. All these activities require a different mindset and a change in your daily routine. This can initially be a stress factor, but it's worth it as an end result. Your body will be tasking muscles and systems more than ever. With the initial muscle soreness and fatigue, many people get discouraged and give up. If you're going to get in shape, you should start out slowly and then progress to the point where you will actually feel a bit guilty if you don't stick to your workout, but this takes time and effort to work. The new "I feel great" lifestyle will come. The main thing is...don't quit.

An effective fitness program includes:

- a warm-up,
- flexibility and stretching,
- aerobic conditioning,
- anaerobic conditioning, and
- cool-down and stretching.

The warm-up and stretch

The warm-up is an essential part of your workout. It should be adjusted to meet the needs of the type of exercises you plan to perform. Warming your muscles gives the body a chance to deliver plenty of nutrient-rich blood to areas about to be exercised and it also lubricates the joints. The warm-up process should include stretching. Its purpose is to increase and maintain muscle flexibility by increasing blood flow to the muscles. Stretching decreases the risk of injury and increases flexibility and range of motion, but stretching should never overextend the muscle or cause it to burn.



5.4 Dakota Ridge Composite Squadron Commander and the Fitness Trainer, start the workout session with a series of stretching exercises. It is highly recommended that anyone starting a fitness program get professional help in stretching techniques. Most fitness centers have staff fitness training specialists who can assist members with this task. Major Sellers is a Civil Air Patrol pilot and his personal lifestyle takes him to the gym three times a week. (Ken Graham image)

5.5 Careful stretching of the wrist is required to handle the weights and machines. (Ken Graham image)



5.6 A standing stretch gets the calf muscles ready for a workout. (Ken Graham image)

Aerobic conditioning

After going through a stretching session, fitness instructors recommend an aerobic (cardiovascular) activity. Aerobic exercise is any activity that uses large muscle groups. The exercise tasks the heart



*5.7 CAP Cadet
Caitie Graham is
shown the hip
flexor stretch.
(Ken Graham
image)*

and lungs and causes each to work harder than when at rest.

Some examples of aerobic activities are:

- cycling either on a bicycle or a stationary bike,
- fitness walking,
- jumping rope,
- running or jogging,
- stair climbing,
- swimming,
- sports, such as racquetball or tennis, and
- organized sports, such as softball, basketball, or volleyball.

Anaerobic conditioning

The effectiveness of your workout would be greatly diminished if it didn't include some type of an anaerobic or resistance training as a basic component of a fitness program. This type of training tasks a particular muscle group to increase its strength and tone. Exercises can be done by using resistance machines, free-weights, or resistance bands (like Bow-Flex machines). While free-weights have the advantage of being the most effective, they have the disadvantage of not being as safe as machines. No matter which you choose, it is best to

5.8 CAP Cadet Dan Eckard starts his aerobic workout on a stair machine.
(Ken Graham image)



5.9 CAP Cadet Travis Graham is shown how to change pace in his aerobic workout on a treadmill.
(Ken Graham image)



consult with a certified fitness professional for proper instruction on equipment use and customizing a “lifting program” tailored to your specific needs. Some examples of these types of workouts are:

- squat,
- bench press,

- dead-lift,
- bicep curl,
- triceps extension,
- military press, and
- rowing.



*5.10 For anaerobic training, it is very important to have professional instructor provide guidance, especially with free-weights.
(Ken Graham image)*



*5.11 Cadet Michael Kay is being shown the proper techniques for using a machine.
(Ken Graham image)*



*5.12 If you want to fly one of these, like Capt. Rick Vigil, you're going to have to stay in peak physical condition throughout your flying career.
(Image courtesy of Adam Wright)*

Cool down and stretching

This is the finishing touch and a very important part of an overall workout. It keeps the body active, prevents the blood from pooling in your extremities, and flushes the muscles of lactic acid. The cool-down should be performed at a low-intensity of effort, starting with the major muscle groups. Similar to the start of the workout, the cool-down period should also involve stretching. A good cool-down with stretching also helps to limit muscle soreness later.

Nutritional considerations

Proper nutrition, fluid intake, and rest and recuperation are important factors for any healthy lifestyle. As your exercise routine increases, nutrition becomes more important because the body needs adequate supplies of proper foods to function well. Eating balanced meals helps to replenish the nutritional needs of muscles and aids in recuperating from your workouts. A balanced meal means being aware of your intake—especially proteins, carbohydrates, and fats. Most individuals involved in a moderate exercise lifestyle benefit from a diet consisting of meals that are 50-55% complex carbohydrates, 15-20% protein, and 25-35% fat; however, the carbohydrate and protein intake percentages can change depending on the purpose of your exercise program.

Dehydration is a problem for most people, especially when they



5.13 *There's a new club in town — Club Veg!* (Ken Graham image)

begin a fitness program. Exercisers should drink more water than ever before to avoid fatigue and cramping. The average sedentary person needs two to four quarts of water every 24 hours for normal functioning. Your water intake can increase or decrease depending on your workout, the weather, and your physical condition.



5.14 *A healthy lifestyle is usually made up of a few less burgers and a lot more salads.*

The obesity problem

Glenn R. Stoutt, Jr. MD is a senior Aviation Medical Examiner based in Louisville, KY. He has been an active AME for 45 years and also holds a commercial pilot's certificate with instrument, multi-engine, and CFI ratings. Dr. Stoutt writes on one of America's most serious medical problems, obesity. His article, "Just for the Health of Pilots – The Epidemic of Obesity," located on the website FAA.gov/library/reports/medical/hop/media/obesity.pdf.

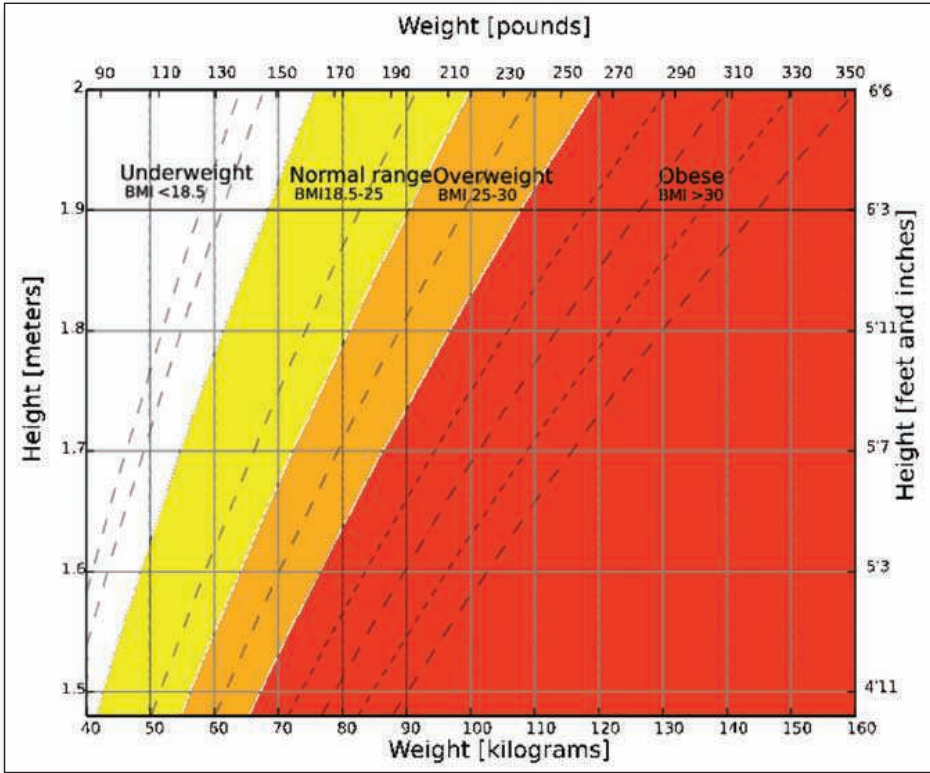
Dr. Stoutt states, "The epidemic of obesity is now a crisis. It is one of the major public health problems in the country. About 300,000 deaths yearly are a result of complications of obesity, second only to smoking, which accounts for about 420,000 deaths yearly.

Medical problems associated with obesity include heart attack, stroke, gout, diabetes, gall bladder disease, arthritis of weight-bearing joints, depression, fatigue, breast and uterine cancer, hypertension, and increased risk of falls and accidents. Add to this decreased self-esteem, less success in the workplace, and even public scorn and ridicule for gross obesity. Pilots may not be able to fit into the cockpit. No FAA regulation about obesity...yet.

Many articles use the Body Mass Index (BMI) to identify obesity...The only accurate way to define obesity is to measure actual body fat content by immersing the entire body in a tank of water and then making some mathematical calculations...A BMI over 27 indicates that you are overweight; if it is over 30 you are probably obese. A BMI of 25 is about right but a BMI under 18 is abnormal. One problem with the BMI is that muscular people (muscle weighs much more than fat) might have a falsely high BMI. The real value of the BMI is to compare population weights over the years. Records of our weights and heights from past decades are readily available from insurance companies and hundreds of other sources. In 1960, 10% of our population was considered overweight; that figure has now reached over 32%. We are the fattest nation in the world."

Dr. Stoutt continues, "The U.S. Department of Health and Human Service's food pyramid may be the most valuable one source of nutritional information ever devised. It contains most of the information you will ever need to know about your diet. It emphasizes food from the five food groups..."

Every major health organization endorses the food pyramid. Our basic diet should be about 15% protein, 20-30% fat (mostly unsaturated) and 55-60% carbohydrates (mostly complex carbohydrates). The popular diet books merely juggle the food percentages instead



5.15 The Body Mass Index chart. (Courtesy of the World Health Organization.)

of just lowering calories by shrinking the pyramid and keeping the proportions the same. Some of the books recommend dangerously high proportions of fat and high protein. Anyone will lose weight on these diets, or on just about any diet, if followed long enough. Even if you eat half a stick of butter and two hamburger patties for each meal you will lose weight. But you will have way too much fat in your diet and will go into a state of ketosis (metabolizing fats into excessive fatty acids), which is also dangerous for your body. No one argues that refined sugar is bad for you. No one ever got into poor health by a lack of sugar. The bottom line is to use the proportions recommended by the food pyramid and forget all the hype, and exercise, exercise, exercise. Even walking 30 minutes every day will do wonders.

Here are the five food groups, with some choices for World Cup Champion in each category:

1. Bread, cereal, rice, and pasta (the mainstay of your diet): Bread (especially whole-grain breads), oats, rice (brown rice is best), macaroni, spaghetti. Try unsweetened whole-grain breakfast cereals and add a little artificial sweetener.



*5.16 It's time to re-think the caffeine and the sugars!
(Photo by Ben Millspaugh)*

2. Vegetables: The winners are Irish potato, sweet potato, broccoli, spinach, carrots, squash, cauliflower, and green peas.

3. Fruits: Favorites are apples, oranges, grapefruit, bananas, watermelon, apricots, and prunes. (Consider vegetables and fruits in the same category nutritionally.)

4. Milk, yogurt, cheese: Best are skim milk, no-fat yogurt, and low or no-fat cottage cheese.

5. Meat, poultry, fish, dried beans, eggs and nuts: Lean meat, about the size of a credit card and about as thick as your finger, once a day; turkey is a good choice. Beans: lima, kidney, navy, black, pinto and black-eyed peas. Three or four eggs a week. Most nuts, if they are unsalted. Salmon, cod, halibut, and tuna are excellent fish selections.

6. Fats, Oils, and Sweets: Bad news. Use sparingly. (Salt, sugar, and fats are the worst things you can eat.) The best oils are olive oil and peanut oil, followed by corn, safflower, soybean, and sunflower. Skip any saturated oils and fats.”

Basics of nutrition and weight control

According to Dr. Stoutt,

- “You need 15 calories per pound per day to maintain your weight with normal activity; you will lose weight on 10 calories per pound. Most women will safely lose weight on 1,200 calories a day, men on 1,500. Consult your physician or a nutritionist to find out which diet best suits your needs. For instance, the amounts of salt or fat may have to be altered if you have high blood pressure or high cholesterol.
- Aim to lose fat, not weight. Rapid weight loss is mostly water.

In crash diets or prolonged low-calorie diets (500-800 calories per day) fat is lost, but so is muscle and other valuable tissue. Remember that your heart is a muscle. Don't try to lose in one month what you have put on over years.

- Your body must burn 3,500 calories to lose one pound of fat. The optimum weight loss is about 1 pound a week. It sounds discouraging at first, but this amounts to 12-24 pounds a year of weight that has an excellent chance of staying off.
- There is no known food that melts fat.
- For each year over 30, your body burns 1% fewer calories, probably because of less muscle mass. So, at age 50, you burn 20% fewer calories than you did 20 years before. No wonder we put on the pounds as we get older. Also, as we age, most of us are less active and need dietary adjustments and a regular exercise program.
- Modern man has exactly the same genetic makeup as Early Man (about 35,000 years ago). Forget the books and articles that say the reason we are fat is because Early Man did not eat cereals and sugar and so on. Early Man did not have Chevrolets, Burger King, or TV, and spent about four hours a day roving about—walking to forage for food and running to keep from being eaten. Our obesity problem has become an epidemic only in the past 50 years.”

On Exercise and Heart Disease

Dr. Stoutt says, “A heart attack (myocardial infarction) can ruin your whole day. Heart disease is the leading cause of morbidity and mortality in the United States, accounting for 50% of deaths each year. This amounts to about 1.5 million heart attacks of which 500,000 are fatal. Cardiovascular disease is a disease of lifestyle, and therefore largely preventable.

In the past 15 years, deaths from heart attacks have been reduced 25% and from strokes by 50%. These dramatic decreases have been attributed to exercising (the fitness movement), reduced fat in our diets, control of hypertension, and decreased smoking. Our stressful, almost-mad lifestyle, unfortunately, has not changed much.

Women pilots and pilots' wives take note: Medical research into heart attacks has been mostly directed at men. We all know that men are at a greater risk for coronary heart disease than women.

Not so. After the protective effects of estrogen drop after menopause, women are just as likely as men to have a heart attack.

The American Heart Association has stressed that heart disease is an equal-opportunity killer. But, studies at emergency departments have shown that women with chest discomfort were nowhere as likely as men to get a thorough workup for heart attack.

Also, cholesterol-lowering programs are largely neglected in women, although high cholesterol is just as big a danger, maybe more so, for women. They get a fraction of the bypass surgery and angioplasties compared with men. Women are beginning to speak out about this, and rightly so.

Some good news for women that can be helpful to men also: In the April 1997 *Journal of the American Medical Association*, an article reported a direct relationship between physical activity and lowered mortality in postmenopausal women. Translated: Women who were physically active lived longer. And, the ones who exercised most lived longest.

Dozens of studies show unquestionably that exercise is the number-one weapon (assuming you don't smoke) in preventing heart disease. There is no reason to 'vapor lock' at 30, 40, or 50 if you can lead a healthful, happy, productive life for many more years." Dr. Stoutt says, "Exercise gives us the feeling of relaxation and well-being. We feel better about ourselves.

What is the best exercise? Walking wins as the gold standard. Cost? A good pair of comfortable walking shoes. Less trauma to joints. Practically no risk of injury unless you are bitten by a dog or hit by a car. Good way to burn calories. Can enjoy at any age.

What is absolutely the best piece of exercise equipment? A dog that enjoys a long walk every day. Also, patting your dog will reduce your blood pressure (really—it's proven fact).

Walking should be part of any aerobic exercise program, but experiment and find an activity that you enjoy and will stay with. Jogging, hiking, swimming, bicycling, treadmill, stair climbers, rowing machines...you name it. 'If exercise isn't fun, it won't get done.' Home exercise equipment allows you to watch TV for a half-hour or so to alleviate boredom. Whatever works. Add about 10 minutes a day of resistance or weight training to keep your muscles firm and strong.

So how much exercise do you really need? Pilots like numbers, so here is the conventional wisdom from the experts:

- An absolute minimum of 20 to 30 minutes a day of moderately vigorous exercise three to four times a week.
- The optimum is 30 to 45 minutes of moderately vigorous exercise for most days. More than this will not make you any healthier,

live longer, or do more to prevent a heart attack. You will burn more calories, and you might need the extra exercise for competition, but most persons might actually be worse off from the more strenuous exercise programs.”

Dr. Stoutt thinks, “Putting mathematics into diet or exercise is both boring and futile. I never count calories or fat grams. I don’t count my pulse after exercising. I don’t weigh portions of food. Just learn principles and rules of thumb. After all, these good health habits should be continued for the rest of your life.”

Dr. Stoutt lists these as pearls of wisdom:

“Don’t weigh your protein portions of meat, poultry, or fish to make sure you have the recommended four ounces. A piece of protein about the size of a credit card is just right. Forget about thickness.

Calories and fat grams? Just learn which foods are loaded with fat and calories (and salt), and avoid them as much as you can.

Identify the good foods and eat more of them; identify the bad foods and eat less of them.

In one study, the following figures were derived based on a woman’s weight of 120 pounds and a man’s weight of 170 pounds. These are averaged estimates and may vary with age and existing physical fitness.



5.17 Corporate Captain Rick Vigil maintains a dedicated aerobic fitness program which includes running his dog, Jaxson, at least three times a week. In his article, “On Exercise and Heart Disease,” Dr. Glenn Stoutt said, “...What is absolutely the best piece of exercise equipment? The answer is a dog that enjoys a long walk with you every day.” (Photo by Ben Millsbaugh)

ACTIVITY	CAL/HOUR	
	FEMALE (120)	MALE (170)
Aerobics	325	450
Basketball	325	450
Bicycle (on road)	220	300
Bowling	160	225
Golf 250		350
Hiking	325	350
Racquetball	375	550
Running	860	1300
Skiing	350	640
Soccer	350	600
Stationary Bicycle	575	800
Tennis	380	550
Walking (brisk)	250	350
Weight training	160	280

To get precise numbers, go on the Internet and key in “exercise calorie burn calculator.” You will find several health-related sites that allow you to insert your exact weight and the amount of time you spend doing a particular exercise or sports activity to get an exact calorie count.



5.18 Dr. Robert Sancetta goes over the results of the FAA 8500-8 physical examination with C/MSgt Hannah Schuele. She took the examination in preparation for the Civil Air Patrol summer flight encampment. Passing this physical examination means that she has earned the privilege of flying for the next five years. (Photo by Ben Millsbaugh)

The Federal Air Surgeon's view on health maintenance

In the Federal Air Surgeon's Medical Bulletin, the Federal Air Surgeon, Fred Tilton, MD, MPH, said this in his column: "Hello, everyone. I hope that the arrival of spring has inspired you to 'break out' the clubs, or jump onto the treadmill, or walk a couple of extra miles a day, or to do some other type of physical activity that helps to work off the few extra pounds you might have gained during the winter. Of course, you are much better off if you have established an exercise program that you adhere to, regardless of the season.

I have noticed that if I am not careful, my trousers seem to get a little tighter during the winter months. It is very easy to blame the dry cleaner or the launderer, but unfortunately, the scale usually confirms that the problem is the extra piece of bread or an occasional piece of pie, coupled with early darkness and its associated reduction in a desire to get outside and exercise, that has caused my wardrobe changes.

This problem is compounded if you maintain your weight during the summer, and then start the winter cycle without having lost the extra pounds from the previous sedentary season. It seems that before you know it, you have gained 20 to 40 extra pounds, and you are wondering, 'How could this have happened to me?'

While watching a recent senior PGA golfing match on TV, I reflected that many of the slim and trim players I used to watch on the pro tour in the '70s and '80s were now many pounds overweight. Some of them looked very uncomfortable, and the extra weight appeared to have had a significant negative effect on their performance.

Then again, there is the occasional competitor, like Gary Player, who set a record by playing in his 52nd Masters tournament. Gary always had a reputation for maintaining a high level of fitness, and that has enabled him to compete far beyond anyone's expectations."

Dr. Tilton reminds AMEs, "You have the opportunity to directly affect the health and lives of the pilots and air traffic controllers you examine. Unfortunately, as I have remarked in past editorials, you may be the only practitioner they see on a routine basis. When you review their 8500s, be sure to consider all of their vital information. If you see any negative trends or if you notice they have gained a few pounds since their last physical, talk to them about it. Tell them about Gary Player or perhaps someone who has allowed his or her health to degenerate, and remind them about the, 'ounce of prevention story.'"

The Federal Air Surgeon, Dr. Tilton, is recommending that all of

the AMEs in the field now address the issue of fitness and good health. Dr. Stoutt states in his obesity article, “After all, good health habits should be continued for the rest of your life,” and now the FAA is recommending a discussion of this issue to the doctors who give the 8500-8 examination.

A lifetime of good health, good food, and physical fitness will keep a pilot at the peak of his or her performance capabilities. This is especially important in view of the advances in high-performance aircraft and aerospace technology. Maintaining the highest level of fitness requires commitment; and, in the world of aviation, this means a zero tolerance for drug and alcohol abuse.

If you want the rewards, you have to make the decision for life-long fitness and you must stick to it. A portion of the material for this unit came directly from a new FAA brochure titled *Fit for Flight-Developing a Personal Fitness Program* (Publication No.AM-400/09/2) and other FAA publications. The last topic in this



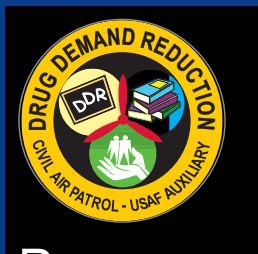
5.19 A well-equipped fitness training center is a “plus” for any program. Large operations offer machines, free weights, running tracks, a swimming pool, and professionally-certified trainers for all age groups. (Photo by Ben Millsbaugh)

brochure has exactly the same message that the Civil Air Patrol Drug Demand Reduction Program has for all of the Civil Air Patrol membership: Physical fitness is a proven component of a long and healthy life. Physical fitness can also prolong your aviation career by helping you pass your flight physicals. The ball is now in your court!



5.20 Netjets Captain Rick Vigil said in an interview, “Every morning I am excited because I actually get to go to work — I have the greatest job in the world!” Just think, this could be you!

(Image courtesy of Netjets)



Educational Programs Directorate

Drug Demand Reduction Program

Civil Air Patrol National Headquarters
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