AVIATION PHYSIOLOGY IN GENERAL AVIATION: A STUDY OF COLLEGE AND UNIVERSITY CURRICULA REQUIREMENTS AND RECOMMENDATIONS

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INTRODUCTION

Humans have always seemed fascinated with the thought of flight as numerous historical descriptions report. Greek mythology details the story of Daedalus and his son Icarus, who designed wings of waxed feathers attached to their bodies. However, Daedalus was cautious and warned his son not to soar too close to the sun because of the dangerous heat and the resultant softening of the wax. The escape from the island was successful, however, Icarus, carried away by the moment, flew too near the sun and suffered the penalty (Dehart, 1985). Similar stories abound in many different cultures over the centuries. Apollo flew across the sky in a chariot carrying the sun, and even more recently is the tale of Santa Claus who rides through the sky annually in his sleigh.

Aviation, separated from mythology, is a relatively new phenomenon that is often associated with the early part of this century and normally identified with heavier-than-air vehicles. Human flight actually began much earlier in lighter-than-air balloons filled with hot air. The Montgolfier brothers of France experimented with small pieces of cloth, filled with smoke. As they watched their invention drift toward the ceiling, they discovered the first lighter-than-air flight platform (Cohen, 1942).

The first flight with occupants carried animals rather than humans. In 1783 the Montgolfier brothers sent a chicken, a duck, and then a sheep aloft in a hot-air balloon. Encouraged by their success, they sent the first human being, Piatre de Rozier, aloft just one month later, tethered below a large smoke-filled balloon (Cohen, 1942). Truly, this was the first manned flight. People had started to realize a dream that had captured the imagination of an untold multitude for centuries. Ironically, the first person in flight was later to be the first aviation fatality. Two years passed with no fatal accidents in ballooning until 1785 when de Rozier attempted an experimental flight in a combined hydrogen and hot-air flight. He and a passenger were killed because of the explosion that resulted when de Rozier attempted to light the fire (Armstrong, 1939).

The human dream of flight was bounded by the reality that limitations exist. Balloon flights began to gain new heights, especially when J.A.C. Charles introduced hydrogen into the balloon replacing hot air. Later in 1783, his hydrogen filled balloon rose 3,300 feet above Earth and soon reached even greater heights. This increase in capability took three Italians to a height of 23,000 feet in 1804. At that attitude they experienced frostbite, vomiting, and all three lost consciousness. The problems of altitude were not totally unknown because studies from mountaineering expeditions provided a plethora of information. The rapidity of the ascent and the lack of physical exertion was, at that time, however, thought to prevent the physiological problems that mountain climbers experienced (Armstrong, 1939).

The first detailed accounts of physiological problems associated with lighter-than-air flight was accomplished by Glaisher and Coxwell in 1862. During their ascents to 31,000 feet, they reporrted a quickening of pulse at 18,000 feet, at 23,000 feet breathing was affected and palpitations experienced, cyanosis was evident, and vision became blurred. At 25,500 feet, Glaisher became ill and vomited. At 34,000 feet, both aviators experienced extreme fatigue to the point of relative incapacitation (Cohen, 1942). Thankfully, Coxwell was able to grab the valve cord with his teeth, releasing the hydrogen.

Paul Bert was very interested in the accounting that Glaisher and Coxwell gave of their balloon flight. Bert was a physiologist and physician who was extremely interested in aviation. His work, *Barometric Pressure - Researches in Experimental Physiology*, was a major contribution to the knowledge gained on the related stresses from aviation (Armstrong, 1939). One of Bert's conclusions was that, regardless of barometric pressure, air cannot support life when the partial pressure of oxygen drops below a certain level. Bert constructed the first known hypobaric chamber in 1878 to conduct experiments in relative safety and under controlled conditions. He used the chamber to demonstrate to two aeronauts the effects of decreased oxygen, partial pressure, and the benefits of breathing oxygen at altitude. This demonstration quickly convinced the two aeronauts about the necessity for supplemental oxygen; they immediately began using oxygen on all subsequent flights.

These same two aeronauts, joined by another aeronaut, attempted a flight to high altitude. Prior to the flight they contacted Bert and outlined their intentions and the amount of oxygen that would be available. Bert responded that the supply was inadequate. The aeronauts decided to ignore the warning of Bert and launched their flight on April 15, 1875. When the balloon was recovered, only one of the three remained alive; the other two died from hypoxia (Armstrong, 1939).

The birth of practical heavier-than-air aviation came on December 17, 1903, with the flights of Orville and Wilber Wright near Kitty Hawk, North Carolina. The events of that day propelled aviation into a new era full of challenges to be met by people and machine. The airplane developed rapidly in just a few short years. Flights became longer, higher, and faster. The production of aircraft was very rapid, especially for export to Europe where the world stood poised for the first world war. The United States Army had a passing interest in the airplane and purchased its first aircraft on February 10, 1908. Just nine months later, however, Lieutenant Thomas Selfridge became the first fatality in an airplane during the testing of one of the first U. S. Army airplanes.

Little was known of aviation and its relationship to medicine, especially the problems associated with the aircraft up until that time, because few researchers other than Paul Bert had experimented or written about the problem associated with aviation. In 1907, a series of papers were written in France dealing with physiological factors, mainly airsickness. Literature reviews of the late twentieth century could find only 32 medical publications concerning aviation medicine (Armstrong, 1939).

World War I dramatically changed the role of the airplane. As the airplane developed, the new capabilities demanded a better selection of pilots, especially for those who flew the airplane in combat. During the intense training of pilot candidates for World War I, 50% exhibited neurosis during training. Additionally, it was found that in 90% of all the wartime aircraft accidents were attributed to physical defects in the pilots themselves (Cohen, 1942). The conclusion was quickly reached that not all people selected for military service were fit for flight. In 1912, the War Department issued the first instructions concerning the physical characteristics necessary for the pilot candidates.

The physical requirements mainly centered on vision, ears (hearing, middle ears, and vestibular function), equilibrium, respiration, and circulatory systems (Dehart, 1985).

The need for medical research in this new area soon became apparent. Schurmeier reported that men complained of vertigo and headaches when flying at altitudes between 12,000 and 16,000 feet, and that these symptoms were dispelled by "deep inhalation" (Schurmeier, 1989). He suggested that a small oxygen tank with an inhaler be required on every aircraft. In 1918 the Army realized the need for answers to many physiological problems and proceeded to establish a medical research center at Hazelhurst Field, Mineola, Long Island (Armstrong, 1939).

The main thrust of interest and investigation at the medical research facility was the problems associated with the need for oxygen at altitude, development of an altitude tolerance test, aerial equilibrium and orientation, and reaction time tests. Several significant contributions to aviation medicine were made at this research facility. Soon after the end of the war, however, it was no longer deemed necessary and was abandoned in 1920. Parallel to the closing of the research facility at Hazlehurst, a decision was made to train medical personnel with special emphasis on aviation. This was the birth of the flight surgeon designation. The first school was initially a part of the research facility at Hazelhurst and the school continued after the center ceased research activity. Eventually the school moved to Brooks Field, Texas in 1926 (Armstrong, 1939). This is the present location of the flight surgeon school, as well as the location for the United States Air Force aerospace research facility named Armstrong Laboratories.

Civil aviation grew after the war. Eventually, the civilian need for physical requirements was evident and the Air Commerce Act of 1926 initiated what was to eventually become the Federal Aviation Administration. A need for an expert in medical issues was identified and Dr. Lewis Bauer was recruited to serve in this position. Dr. Bauer immediately developed the first medical standards for civilian pilots and mandated standards (Dehart, 1985). Additionally, a civilian aeromedical research facility was established in 1938 at Kansas City, MO. This facility, now known as the Civil Aeromedical Institute, is now located in Oklahoma City, Oklahoma in the Aeronautical Center ran by the Federal Aviation Administration.

The development of the aircraft continued at an exponential rate between the two World Wars, especially when one considers the inception of aviation was just 33 years earlier. Aircraft had found a solid niche in the military and the capabilities were rapidly exceeding the physiological tolerances of pilots. Flight was routinely conducted at high altitudes, aircraft speeds reached approximately 450 miles per hour, aircraft were stressed for high acceleration factors, and all weather flying was accomplished daily (Dehart, 1985). Humans could not match the evolution pattern of the aircraft and quickly found certain aspects of flight to be formidable, such as decompression sickness brought about by long duration, and high altitude flights of the bombers. Mechanical solutions were found for some of the problems, but not all of them were associated with the high performance aircraft. An education program appeared to be at least part of the solution.

In 1943, after thousands of interviews with aircrew, it was deemed necessary to educate the flying population on the effects of high altitude flight. The idea of initial and recurring training was initiated and signaled the beginning of physiological training for all the aircrews. Just a year later, it was decided that medical corps officers would be qualified to teach in this new arena, as would carefully selected pilots. The pilots had to have experience with high altitude flight, as well as the proper educational background (Green, 1968). This synergistic approach brought a new dimension to the aircrew education program.

Aviation physiology was required training for all aircrews during their initial training, and renewed training every three years. Initially, the course centered around the hypobaric chamber and the effects of altitude. As aircraft grew in complexity, speed, and endurance so grew the curriculum of the aviation physiology course. Although still centered around the hypobaric chamber, new classes were added to include subjects such as noise, vibration, vision, spatial disorientation, acceleration, and fatigue (Appendix A).. Thousands of aircrew have been trained over the years concerning these areas of physiology.

Civilian training in these areas lagged behind the military for many reasons. Although a civilian research facility existed, an education program devoted to training private pilots on the effects of aviation on human physiology was lacking. Debate was waged on the actual need to train civilian pilots in this area. Furthermore, civilian aircraft at that time, for the most part, did not have the performance capability of the military airplanes. Additionally, most civilian pilots were not instrument certified and most civilian aircraft had insufficient instrumentation to fly in instrument meteorological conditions (IMC) (Dehart, 1985). It was deemed unnecessary, therefore, to duplicate the military training courses, but it was decided that the general aviation flight instructor was to accomplish aviation physiology training for the individual student.

It was assumed that instructors had the requisite knowledge to instruct in this area with no formal training. Additionally, exactly what was to be covered, the lack of standardized format, and how much detail were also questioned. Finally, if the instructor actively sought to include detailed information in his instruction, it was difficult to obtain. These are some of the same questions we have in civilian aviation today.

In 1967, the Civil Aeromedical Institute (CAMI) initiated physiological training at the Aeronautical Center ran by the Federal Aviation Administration in Oklahoma City, Oklahoma. Attendance in the physiological training conducted at the CAMI, was and still is voluntary. The Civil Aeromedical Institute Physiology End of Course Critiques of 100 pilots who attended the training attest to the value of its content and highly recommend the training for all pilots.

The current syllabus of instruction at the CAMI is completed in one day and is culminated with a flight in a hypobaric chamber. Included in the instruction are classes on physics of the atmosphere, respiration and circulation, hypoxia, hyperventilation, decompression sickness, cabin pressurization, principles and problems of vision, noise, spatial disorientation, oxygen equipment, self-imposed stress, physical fitness, and survival (Physiological Training, 1990) (Appendix B).

The current Federal Aviation Regulation (FAR) requirement concerning pilot training does not specifically address the issue of physiology for the students (Federal Aviation Regulations 61.87 (b), 61.105, 61.125, 61.153, and 61.185). The requirement is covertly expressed throughout the regulations. The Certified Flight Instructor must assess if the student has sufficient knowledge to pass the written and practical tests. These tests include physiological factors. No specific requirement exists, except for flight above

25,000 feet, for pilots to receive training on hypoxia, hyperventilation, spatial disorientation, and decompression sickness. Each flight instructor is individually responsible for the development of the lesson plans to accomplish pilot training. An informal survey by this author of ten flight instructors indicates a wide variance in personal knowledge in this subject and a lack of formal training in this area. Furthermore, when asked if they were comfortable in teaching this subject, seven of the ten responded "No" (Unpublished, Conway, 1994).

Modern aviation has not overcome the physiological problems that have plagued humans in flight since de Rozier. Civilian aviation today still has numerous accidents attributed to physiology. The National Transportation Safety Board has verified the pilot to be the causal factor in 60% of all aviation accidents and suspects this number is actually 80% of all aviation accidents (Aircraft Owners and Pilots Association, 1993). In general aviation the number of accidents attributed to physiological problems counted for 193 accidents; 406 fatalities, 120 seriously injured, and 34 minor injuries during the period 1990 through 1993. Of these 193 accidents, 109 were attributed to spatial disorientation, 32 to stress and fatigue, 17 to inflight sickness, 12 to alcohol, 8 to drugs, 8 to human factors, and 4 to hypoxia (National Transportation Safety Board, 1994).

An evaluation of the total accidents in general aviation during 1990 through 1993, however, revealed 8,480 accidents with 1,705 fatalities (National Transportation Safety Board ARG 94/01). In accidents, the physiological factor accounted for only 2.3% of aviation accidents, but physiological factors account for 13% of aviation fatalities during the period from 1990 though 1993.

Presently, approximately 588 certified flight schools exist in the U.S. and about one-third are part of collegiate programs (Federal Aviation Administration AC No:140-2V). Some of these schools have formal classes for college credit on the required aviation subjects whereas some require only home study.

As identified by DeHart (1988), history indicates that humans have a physical problem associated with various aspects of flight. Accidents from physiological problems appear to be on the increase in general aviation because of the expansion in aircraft capability and the growth in total number of licensed pilots. An area of concern is the number of pilots who have not received formal education about high performance flight.

Numerous incidents recently attest to the need for additional training in the area of aviation physiology. Clark and Rupert found that loss of spatial awareness has been implicated as a direct causal factor in 4-10% of serious aircraft mishaps and 10-20% of fatal aircraft mishaps (Clark & Rupert, 1992).

Reyman, in his review of hypoxic episodes in the United States Air Force between 1970-1980, indicated that 298 airmen reported episodes of in-flight hypoxia. None of the incidents were serious, but the potential was there. Researchers account for the early recognition and treatment of hypoxia through the physiological training program (Rayman & McNaughton, 1983). Additionally, a recent incident of decompression sickness in a general aviation pilot was documented. The pilot went undiagnosed for nearly two years before the proper diagnosis was made (Black & DeHart, 1992). These authors also call for increased education of pilots.

The call for increased education of general aviation pilots is strong. In addition to the National Transportation Safety Board reports are the self-initiated reports using the Aviation Safety Reporting System (ASRS) of the National Aeronautics and Space Administration. An ASRS database search revealed that 28 hypoxia incidents were reported in the last eight years (Appendix B). Several reports called for increased education in physiology, but report ASRS #245583 succinctly state, "The best solution to this problem would be an on-going training program to keep these procedures fresh in our minds in addition to a once a year trip through the flight simulator" (ASRS #245583, p. 73).

Nearly every incident involving physiological factors calls for a training program to educate pilots on the hazards involved with the operation of aircraft under various circumstances (DeHart, 1988). The Federal Aviation Administration conducted its own survey (Federal Aviation Administration-91/13) titled Civilian Training in High-Altitude Flight Physiology. This study concluded that a need for greater pilot education and a lowering of altitude requirements for oxygen usage existed.

So far, the response by the Federal Aviation Administration has been to add Federal Aviation Regulation (FAR) 61.31 (f) 1 stating,

> . . . no person may act as pilot-in-command of a pressurized airplane that has a service ceiling or maximum operating altitude, whichever is lower, above 25,000 feet MSL unless that person has completed the ground and flight training specified in paragraphs (f)(1)(i) and (ii) of this section and has received a logbook or training record endorsement from an authorized instructor certifying satisfactory completion of the training. The training shall consist of: (i) Ground training that includes instruction on high altitude aerodynamics and meteorology; respiration; effects, symptoms, and causes of hypoxia and any other high altitude sickness; duration of consciousness without supplemental oxygen; effects of prolonged usage of supplemental oxygen; causes and effects

> of gas expansion and gas bubble formations, and high altitude sickness; physical phenomena and incidents of decompression; and another physiological aspects of high altitude flight . . . (p. 61-69).

Statement of the Problem

What are the major curriculum elements of college and university course work in aviation physiology? The problem is that no summary or analysis has been made of what UAA member universities presently cover and perceive should be taught with regard to physiology in an aviation physiology education program. This information is needed to assist today's curriculum designers and developers. This study investigated the current curriculum presented to student pilots in college or university aviation programs. This study also collected data and recommendations for an optimum syllabus and training program in aviation physiology suitable to college and university aviation programs.

Significance of the Study

General aviation has a long history of advances and accomplishments since the invention of the heavier-than-air machines. Advances in aviation technology and performance have placed increased demands on the capability of humans to adapt to an unfamiliar and often hostile environment. Numerous accidents related to the high altitude environment document this fact. These advances, as well as most researchers and pilots themselves, call for the education of general aviation pilots on the physiological factors associated with flight. Currently, no consensus exists on the curriculum offered to the students in aviation. The Federal Aviation Administration requires pilots to demonstrate knowledge of aeromedical factors, but are unclear as to the curriculum required to attain this knowledge. The student is required to learn a minimum amount of physiological information in either a ground school or home study. The student must pass the appropriate Federal Aviation Administration written test, which includes questions concerning aeromedical factors. Therefore, the need for a comprehensive curriculum in aerospace physiology is indicated by the researchers and pilots and will reflect the desires of the general aviation population and academicians.

Assumptions of the Study

To complete this study, the following assumptions were made:

1. The participants responded to the questionnaire honestly.

2. The physiological survey is a valid way of describing the development of an aviation physiology curriculum.

3. The questionnaires returned are suitable for data interpretation.

Limitations of the Study

The subjects of the study are limited to the 105 University Aviation Association (UAA) schools. The UAA population was selected based on the charter and by-laws to develop and enhance aviation education (Appendix D).

Definition of Terms

Federal Aviation Administration. A part of the U.S. Department of Transportation since 1967, the Federal Aviation Administration (FAA) is responsible for regulating the technical aspects of civil air transportation. (The economic regulation of airlines is a responsibility of the Civil Aeronautics Board.) The Federal Aviation Administration establishes safety standards for aircraft and medical standards for personnel, operates and maintains communications equipment and control towers at airports, develops and tests navigation equipment and improved aircraft, and investigates airplane crashes. The Federal Aviation Administration also helps plan and develop public airports and provides numerous other technical services. Until its absorption by the Department of Transportation in 1967, it was called the Federal Aviation Agency.

Hypoxia. Hypoxia is a deficiency of oxygen in body tissues. The reduction of oxygen is of particular concern to fliers, as there are few effects from hypoxia at lower altitudes. This condition is commonly called altitude sickness. Above 9,000 feet the depth and rate of breathing and the heart rate increase, and this may produce headaches, giddiness, and inability to concentrate. Impairment of judgment and visual disturbances become serious above 15,000 feet. Loss of consciousness occurs between 25,000 feet and 30,000 feet, and death will result if descent is not rapid or if oxygen is not administered promptly.

Hyperventilation. Hyperventilation is excessive breathing, most often caused by acute anxiety. During hyperventilation, oxygen levels in the body increase and carbon dioxide levels decrease. This disorder can result in vertigo, dizziness, numbness in the hands and feet, feelings of suffocation, panic, and faintness or actual fainting. It is often accompanied by heart palpitations or heart pounding and gastrointestinal disturbances. The person showing these symptoms may be unaware of overbreathing.

Spatial Disorientation. Spatial Disorientation may exist when an individual does not correctly perceive their position, attitude, and motion relative to the center of Earth. Sensory illusions may lead to spatial disorientation in flight when the pilot is unable to see, believe, interpret, process, or rely on the information presented to the pilot by the flight instruments, but relies instead on the false information provided by the body.

Hypobaric Chamber. A hypobaric chamber is a large rectangular steel tank with outer walls constructed from pieces of angled steel plate, welded together, presenting a corrugated appearance. The interior is furnished with a source of oxygen and communications equipment. It is intended as a training device used to simulate the low barometric pressure of altitude under controlled conditions.

Aviation Physiology. Aviation physiology is the science concerned with the normal vital processes of human life, especially how they function in the aviation environment.

Human Factors. Human factors is a term used to associate the psychology of the aviator interfaced with the aircraft.

Decompression Sickness. Decompression sickness (DCS) is the disorder produced by the evolution of gas from tissues and fluids of the body (nitrogen bubble formation). The types of DCS include simple bends of joints, neurological and pulmonary problems, and skin manifestations.

Inflight Sickness. Inflight sickness is associated with nausea (motion sickness), dizziness, fainting, and headaches. Inflight sickness does not include heart attacks.

Statement of the Hypothesis

Certain factors are known that modify human physiological responses to altitude, visual degradation, spatial disorientation, acceleration, adaptation, noise and vibration problems, drugs, alcohol, illness, and human factor problems (Bert, 1878; Black, 1992; Turner, 1991; & Gillingham, 1985). The literature, as a whole, strongly suggests that a relationship exists between education of physiological factors affecting the performance of aircrew and the levels of education and training on the subject. Therefore, it was hypothesized that the UAA members recommended curriculum for general aviation pilots would reflect the existing United States Air Force physiological training curriculum.

Organization of the Study

The following chapters consist of the following topics. Chapter II, Literature Review: History of Physiology; Physiological Problems of Flight; Physiological Training Programs; Aviation Education Programs; Federal Aviation Administration Physiological Training; United States Air Force Physiological Training; and Summary. Chapter III, Methodology: Instrument; Design; and Analysis.

CHAPTER II

REVIEW OF THE LITERATURE

The review of the literature shows a consensus concerning the problems and effects of physiological factors affecting the human body (Gillingham, 1985; Ernsting, 1984). The review is divided into the various components of the physiological factors identified in the National Transportation Safety Board accident reports from 1990 through 1993. The following areas will be reviewed:

1. Spatial disorientation
2. Hypoxia and hyperventilation
3. Drugs and alcohol
4. Stress and fatigue
5. Human factors
6. Ratification for education
7. United States Air Force and Civil Aeromedical Institute Physiological Training Programs.

Spatial Disorientation

A study of the aviation mishaps in the U.S. Navy from 1980 through 1989, revealed the physiological and behavioral effects of spatial disorientation on flight performance. Description of Type I (unrecognized) spatial disorientation is associated with flying apparently normal operating aircraft into the ground; Type II (recognized) spatial disorientation involved a loss of orientation to the surface of Earth; and Type III (overwhelming) spatial disorientation is the most extreme of the spatial disorientations. The pilot is aware of the disorientation, but is unable to control the aircraft. During this period, 33 Class A mishaps (5% of the total mishaps) occurred from spatial disorientation. The development of training programs that replicate the conditions and parameters associated with day, weather, night, and other spatial disorientation causing parameters was suggested (Bellenkes, Bason, & Yacavone, 1992).

These are essentially the same findings that the researcher Martin-Saint-Laurent (1990) found when he reviewed the causes of sudden inflight incapacitations in Air France pilots and flight engineers from 1968-1988. They reported that the main causes of sudden incapacitation were linked to coronary accidents, epilepsy, and physiological disorders including spatial disorientation, hypoxia and loss of consciousness induced by acceleration. One aircraft became depressurized and resulted in the entire crew experiencing hypoxic symptoms. It took 20 minutes before a crewmember identified the problem and initiated the recovery procedures. They strongly recommended that crewmembers be subjected to "the state of incapacitation as quickly as possible and how to complete the flight safely."

Another study that confirms this physiological problem is the work by Clark and Rupert (1992). They listed spatial disorientation as a direct cause in 4-10 % of serious aircraft mishaps and 10-20% of fatal aircraft mishaps. Case reports were reviewed with respect to spatial disorientation. One conclusion was that the aircrew be trained in dynamic simulators to aid in recovery in disorientation. Furthermore, students/pilots with a history of disorientation problems could benefit from such simulators.

Clark and Rupert's findings generally parallel the accidents attributed to spatial disorientation of the general aviation population reported by the National Transportation Safety Board. During the period from 1990 through 1993, 8480 general aviation accidents occurred; 109 accidents (0.13 % of all general aviation accidents) were caused by spatial disorientation. Those accidents, however, accounted for 214 of the reported 3124 fatalities (0.7 % of all the fatalities during the same period) (National Transportation Safety Board/ARG-94/01).

The mechanics of orientation mechanisms and how they fail in flight are discussed in detail in the publication, Spatial Orientation (Gillinham and Wolfe, 1985). This publication outlines the basis for spatial orientation and the role of proper education regarding the causes, effects, and recovery from the various illusions of spatial disorientation. This document involves a comprehensive review of the mechanics of motion, force, and directions of action and reaction.

Spatial Orientation also expounds on the visual orientation, anatomy of the visual system, and the visual processing system. Vestibular function, anatomy, and vestibular information processing is also well documented. Those subjects are followed by a review of the proprioceptors, cutaneous exteroceptors, and auditory orientation.

Finally, they blend the various reviews into a comprehensive and in-depth discussion of spatial disorientation that includes illusions in flight, disorientation in flight, prevention, and other sensory phenomena (Gillingham & Wolfe, 1985). This follows the pattern in the USAir Flight 105 where the National Transportation Safety Board noted that the crash probably resulted from confusion with runway lights (Aviation, Week, & Space Technology, 1990).

Alcohol, Drugs, and Human Errors

Alcohol, drugs and human errors also appear to be a problem in general aviation accidents accounting for 33 fatalities (13% of the fatalities result from physiological problems). Furthermore, 20 accidents were caused by either drugs, alcohol, or human factors (14.5% of the accidents were from physiological problems) during the period 1990 through 1993; 12 accidents were attributed to alcohol, 4 accidents to drugs, and 4 accidents because of human factors (National Transportation Safety Board/ARG-94/01).

Probably one of the most notorious accidents attributed to human factors was the downing of Korean Airline flight 007. It is believed that the crew made a host of human errors, including entering improper data in the flight computer. Another factor was a hidden agenda by the crew to save fuel to avoid a refueling stop enroute to the destination (Stein, 1983). Human factors appeared to be to a contributing factor in the crash of the L-1011 in the Florida Everglades, the San Luis Obispo crash (1984), and the Western Airline 1979 Mexico City crash (New Scientist, 1986).

The Aviation Safety Reporting System (ASRS) developed by NASA is a voluntary self-initiated reporting of incidents involving aircraft. The 178 cases reported during 1991 and 1992 involved problems associated with human factors and fatigue (NASA ASRS, 1994). Vincoli (1990) reported in his article that a problem definitely exists associated with the human factors and calls for a comprehensive education of the pilot community.

Alcohol is an issue that is constantly debated. Federal Aviation Regulation 91.17 (a) (1), (2), (4) states that "no person may act or attempt to act as a crewmember of a civil aircraft within 8 hours after the consumption of any alcoholic beverage, while under the influence of alcohol, and while having a 0.04 percent by weight or more alcohol in the blood" (p. 91-118). Accident statistics proved that alcohol was a factor in 35.4% of the cases studied (158 studied out of 477 fatal accidents). This establishes that alcohol combined with other physiological properties of flight has a synergistic effect and accounts for most of the accidents in this time period. Furthermore, the author favors an education program for the general aviation population on the hazards of flying under the influence of alcohol or drugs.

A series of questionnaires was completed by professional pilots on their perception of the use of alcohol in aviation today. Pilots noted that alcohol use was a major problem in general aviation, but also rated corporate, charter, regional, and major air carriers as a risk only slightly lower than general aviation. Authors state "these are causes that could be remedied by greater educational efforts, and, indeed, the respondents gave mandatory education a relatively high effectiveness rating for reducing alcohol use in aviation." Notably, respondents felt that the current legal limit of .04% blood alcohol count was too high (Ross & Ross, 1992).

Hypoxia and Hyperventilation

Early in the history of aviation, anoxia was a major concern for the health of the pilot (Armstrong, 1939). Only three years after the first successful balloon flight in 1788 came the first reference in 1786 to an effect of flight which could have been anoxia

(Dehart, 1985). A more precise word to describe this phenomena is hypoxia because anoxia means the complete absence of oxygen. Around 1800 the term "balloon sickness" was popular to describe the effects of high altitude (Dehart, 1985). In a well-documented balloon flight, Glaisher and Coxwell ascended to an altitude of 29,000 feet. Glaisher reported loss of vision, partial paralysis, loss of hearing and finally unconsciousness (Cohen, 1942).

The issue of hypoxia and hyperventilation is the basis for continued debate for the need for lower altitudes, stricter oxygen requirements and better education of the flying population. Federal Aviation Regulation 91.211 (1) states, "No person may operate a civil aircraft of U.S. registry at cabin altitudes above 12,500 feet (MSL) up to and including 14,000 feet (MSL) unless the required minimum flight crew is provided with and uses supplemental oxygen during that part of the flight at those altitudes that is more than 30 minutes; (2) at cabin pressure altitudes above 14,000 feet (MSL) unless the minimum required flight crew is provided with and uses supplemental oxygen during the entire flight at those altitudes; and (3) at cabin pressure altitudes above 15,000 feet (MSL) unless each occupant of the aircraft is provided with supplemental oxygen" (p. 91-138).

In a recent article in *Flying* magazine, the author recounts a personal encounter with hypoxia. His personal account of a hypoxic episode equates hypoxia as a "Circe-like nature." The encounter ended with an uneventful descent and rapid recovery, however the bottom line is that many pilots absolutely believe that "it won't happen to me" (Benenson, 1993, p. 95-96). Furthermore, he states that most pilots believe physical conditioning, acclimatization, and luck will prevent them from suffering the effects of hypoxia.

Mr. Beneson's interview with David Blumpkin, University of North Dakota Aerospace Physiologist and Dr. Frank Dully, a consultant in aviation medicine for the University of Southern California, debated the idea that individual symptoms are patient-unique and that the reliance on a single set of symptoms can pose problems when they are not replicated during a hypoxic episode in the aircraft. Dr. Dully supported this idea whereas Mr. Blumpkin chose the opposite view. The debate centered on the dangers involved in the hypobaric chamber weighted against the training benefit.

Dr. Dully agreed that pilots should experience hypoxia, but not in an altitude chamber.

Dr. Dully believes that training in an altitude chamber is inherently dangerous because of the possibility of a trainee incurring a decompression sickness problem. He postulates that the same effect could be replicated with fractional inspired oxygen at ground elevation. However, one very valid argument against this method is that it would instill an incorrect response to hypoxia. Instead of resorting to donning a mask, the mask providing the gaseous mixture would have to be removed (Beneson, 1993).

Decompression Sickness

Decompression sickness is associated with the effect of Henry's Law which states:

> The amount of gas in solution varies directly with the pressure of that gas over the solution; or, when the pressure of a gas over a certain liquid decreases, the amount of that gas dissolved in the liquid will also decrease (or vise versa). This gas law affects the body in that gases, primarily nitrogen, will come out of solution when the body is exposed to reduced atmospheric pressure. This occurs because the pressure of nitrogen is reduced proportionately as the total atmospheric pressure is reduced. This evolved gas phenomenon may lead to disorders similar to the bends which deep sea divers experience as a result of a rapid ascent

> to the surface (going from an area of high nitrogen saturation to an area of lower external pressure and lower nitrogen saturation, possibly resulting in nitrogen bubble formation throughout the body) (Federal Aviation Administration, 1990).

Obviously, decompression sickness is a primary concern for Dr. Dully (Benenson, 1993). However, David Blumpkin at the University of North Dakota stated that they had never had a verified case of decompression sickness (Benenson, 1993). Furthermore, Kumar (1988) investigated the occurrence of decompression sickness concentrating on 15,000 feet in the hypobaric chamber. He concluded that moderate exercise (75% of $V0_2$ max.) at low altitude may predispose healthy individuals breathing ambient air to decompression sickness. United States Air Force data on decompression sickness from 1978 -1980 revealed one case at 11,000 feet, one at 16,000 feet, and three at 17,000 feet. A total of 58 cases of decompression sickness were reported, six of which were at 18,000 feet or below. However, the level of exercise was not indicated. Kumar concluded a threshold for decompression sickness is arbitrary and individual variations in threshold are very likely (Kumar, 1988).

The safety record of the hypobaric chamber is constantly being challenged. Conklin (1992) collected data over a fifty year span and compiled the databank that reports all known hypobaric chamber exposures from 1942 to 1992. This databank has a record of 130,012 people that were exposed over the fifty years. At altitudes up to 25,000 feet (without exercise) no cases of decompression sickness were reported and with exercise this number increased to 0.5% (Conklin, 1992).

One case of decompression sickness caused by an aircraft flight was recently diagnosed and confirmed (Black, 1992). Aircraft performance of modern planes is capable of flight in the 18,000 to 28,000 feet range and many nonpressurized aircraft are approved for flight above 20,000 feet. Aircraft in this category are the Beech Queen Air (28,500 feet ceiling), Beech Baron (25,000 feet ceiling), Beech Turbo Bonanza (25,000 feet ceiling), Piper Navajo (24,000 feet ceiling), and the Cessna Centurion (28,000 feet) (Turner & Huntley, 1991).

In the one confirmed case of decompression sickness in the aircraft, the pilot became incapacitated after approximately 55 minutes at an unpressurized altitude of 25,000 feet. The oxygen supply was checked prior to the onset of symptoms and again during the episode and appeared to be functioning normally. The pilot became unconscious and the passenger had to land the aircraft. The pilot recovered, but with decreased short term memory, difficulty in concentration, and decreased night visual acuity. The author observed that had the pilot been alone in the aircraft it would have, in all probability, crashed and most likely would have been attributed to hypoxia (Black, 1992).

Aviation Physiology Education

The call for increased education of the pilot concerning aviation physiology is strongly encouraged by several authors (Black, 1962; Ernsting, 1984; Frances, 1991;). In his article Black recommends "... as part of the new aircraft orientation, training in the hypobaric chamber for hypoxia and indoctrination about decompression sickness should be accomplished" (Black, 1992). Ernsting (1984) calls for "All aircrew should receive initial and refresher training in the effects of hypoxia" (p. 408). Gault (1990) recounts the report of an aircraft cruising at 25,000 feet and literally falling out of the sky. The pilot was a 36-year-old commercial pilot with over 2,000 flying hours. The autopsy revealed the pilot was unconscious at time of impact. The pilot was a heavy smoker, and that combined with a stuck pressure relief valve and the unused oxygen, caused the pilot to experience hypoxia. The author firmly recommends training in high altitude to include an altitude chamber experience (Gault, 1990).

A study of the 298 United States Air Force aircrews that experienced hypoxia in-flight revealed no aircraft accidents. The article stated "symptoms of hypoxia are well known to aircrew by virtue of physiological training and periodic (every 3 years) altitude chamber indoctrination" (Reyman, 1983, p. 1103). The article also reported that, "A significant number of aircrewmen stated they recognized that they were becoming hypoxic only because they recalled their altitude chamber training" (p. 1108). During the period 1970 - 1980, 298 incidents of hypoxia were reported compared to the previous period of 417 during the period of 1963 - 1970 (extrapolated value equals 611). The almost 50% decrease was attributed to better life support equipment and training programs (Rayman, 1983).

The improper use of oxygen, however, circumvents the original purpose. Reviews of aircraft accidents that occurred because of improper use of oxygen found an aircraft that was on a training flight with an instructor that liked to have the student experience the reality of flight. He included a rapid dumping of cabin pressure as a routine emergency. At 31,000 feet, however, both pilot and student became irrational and eventually unconscious. Oxygen hoses were found to be disconnected from aircraft during high altitude flight. Furthermore, the oxygen mask was incapable of providing more than 47% concentration of O_2. Use of ground-based hypobaric chambers with the proper safety precautions are the correct way to train for this type of emergency (Underwood, 1982). Clearly, a hypobaric chamber would have been a safer and a saner way to accomplish this training.

The National Transportation Safety Board has encouraged the airlines operating under Federal Aviation Administration Part 121 to strengthen training programs. The National Transportation Safety Board has found in a study of 37 accidents (1978-1990) that the flight crews were causal factors in eight of the accidents. The National Transportation Safety Board cited such factors as situational awareness, cockpit resource management, tactical decisions, and systems operations. Also noted was fatigue and circadian rhythm factors. Several recommendations were made including the training in the effects of fatigue and the reduced ability to perform under certain circumstances (Phillips, 1994).

A recent article in *Flying* magazine depicts the physiological training received at the University of North Dakota Aerospace Foundation. Testimony of various pilots, supervisors, and maintenance technicians gave new light to the realities of hypoxia. One pilot stated, " Even though I had experienced hypoxia before, I had never experienced it to that magnitude, I did not know just how incapacitated one can get from hypoxia" (Benenson, 1993, p. 97). Maintenance personnel became more dedicated to insuring all safety equipment was properly working. Finally, the author recommended this training, as well as the complete physiology training for all aviation related personnel (Frances, 1991).

The call for education in other areas of physiology are equally strong. Gillingham (1986, p. 33) stated, " Physiological training is the main weapon against spatial disorientation . . . this training should consist of both didactic material and demonstrations." Vincoli (1990) and Ross (1992) encourage education in human factors and fatigue. Gibbons (1966) and Ross (1992) also recommend additional education of the flying population as to the effects of alcohol and flying.

The Federal Aviation Agency commissioned a study to determine if additional education on physiological factors was needed in the general aviation population (Turner & Huntley, 1991). Turner and Huntley's report outlined the details of the study undertaken to establish whether or not a need for high altitude flight physiology exists. The survey determined a need for such training, current training practices were not uniform nor all encompassing. They were unable to ascertain how many schools actually taught aviation physiology as a separate course. Additionally, they found only three universities used a textbook for the aviation physiology course. Their report contains recommendations for subjects to be included in a core curriculum and additional subjects that might be included (Turner & Huntley, 1991).

The aviation industry is having a significantly greater effect on collegiate aviation curricula. College graduates with a course of study that emphasized aviation would appear to be better prepared to assume a position of responsibility in aviation operations. Eastern Airlines planned to enroll up to 4,000 students per year in the aviation programs at Miami Dade Community College and Aims Community College. Their goal was to train professional pilots to fill the future needs (*Aviation Week & Space Technology*, 1987). Northwest Airlines has established a similar *ab intro* pilot training program with the cooperation of the University of North Dakota (Hughes, 1987). T. Allen McArtor, then Federal Aviation Administration Administrator, called for an industry-wide review of pilot training in 1987 (Aviation Week & Space Technology, 1987). Finally, the review by

Smith (1989), reviewed several *ab intro* pilot training programs and stated that the "college trained airline pilot is a reality" (p. 41). He also noted that few other programs are available to the airlines (Smith, 1989).

Obviously, a consensus of opinion exists of the need for increased education of the pilot in aviation medicine and that universities and colleges are the schools for the flight training.

Aerospace Physiology Training Programs

The United States Air Force has conducted physiological training since 1943. The original program concentrated on the hypobaric chamber and the effects of altitude. Over the decades it has evolved to its present state of an original seven-day course followed by a one-day recurring training every three years. The current original physiological training program according to the Department of the Air Force, Headquarters Air Education and Training Command, Randolph Air Force Base, Texas, P-V4A-A-AP-IG/S-V8N-C-CPA-IG, July 1993 is as follows:

1. Course Introduction and the Atmosphere — 1 hour
   - -- Atmospheric characteristics
   - -- Pressure measurement
   - -- Altitude measurement
   - -- Physical divisions
   - -- Physiological divisions
   - -- Gas laws

2. Respiration and Circulation — 1 hour
   - -- Phases of respiration
   - -- Anatomy and physiology
   - -- Control of ventilation
   - -- Integrated responses
   - -- Oxygen delivery

3. Hypoxia and Hyperventilation — 2 hours
    - -- Types of hypoxia
    - -- Factors influencing hypoxia
    - -- Recognition of hypoxia
    - -- Prevention of hypoxia
    - -- Treatment of hypoxia
    - -- Pressure breathing
    - -- Causes of hyperventilation
    - -- Characteristics
    - -- Recognition of hyperventilation
    - -- Prevention of hyperventilation
    - -- Treatment of hyperventilation

4. Effects of Pressure Change — 1 hour
    - -- Boyle's Law review
    - -- Areas of trapped gas
    - -- Effects of ascent and descent
    - -- Decompression sickness
    - -- Henry's Law review
    - -- Theory of decompression sickness
    - -- Decompression sickness symptoms
    - -- Factor affecting decompression sickness
    - -- Protection and treatment of decompression sickness

5. Self-Imposed Stress — 2 hours
    - -- Use of over-the-counter drugs
    - -- Effects of over-the-counter drugs
    - -- Alcohol and tobacco use
    - -- Nutrition
    - -- Fatigue
    - -- Combating stress

6. Situational Awareness — 1 hour
    - -- Attention anomalies
    - -- Inappropriate motivation
    - -- Improving situational awareness

7. Acceleration — 2 hours
    - -- Types of acceleration
    - -- effects of gravitational forces
    - -- Physiological effects of gravitational forces
    - -- G-induced loss of consciousness
    - -- Anti-gravitational strain maneuver

8. Noise and Vibration — 1 hour
   - -- Characteristics of noise
   - -- Perception of sound
   - -- Protection
   - -- Frequency of vibration
   - -- Effects of vibration on performance
   - -- Symptoms

9. Vision — 2 hours
   - -- Anatomy and function of the eye
   - -- Characteristics of vision
   - -- Day vision
   - -- Night vision
   - -- Night vision demonstration

10. Spatial Disorientation — 4 hours
   - -- Definition and classification
   - -- Orientation and sensory systems
   - -- Vestibular induced spatial disorientation
   - -- Factors affecting spatial disorientation
   - -- Prevention
   - -- Spatial disorientation trainer

11. Oxygen Equipment — 2 hours
   - -- Oxygen storage systems
   - -- Oxygen delivery systems
   - -- Pressure demand regulators
   - -- Emergency oxygen systems
   - -- Preflight checks
   - -- Oxygen laboratory

12. Aircraft Pressurization — .5 hour
   - -- Pressurization
   - -- Decompressurization

13. Type I Hypobaric Chamber Flight — 2 hours

14. Type II Hypobaric Chamber Flight and Rapid Decompression — 2 hours

15. Type IV Hypobaric Chamber Flight — 1 hour

16. The Parachute -- Components and devices -- Inspections -- Procedures	1.5 hours
17. Descent and Landing Techniques -- Suspended ring and harness training -- Parachute landing fall practice -- Drag recovery	4 hours
18. Parachute Familiarization Training -- Parasailing	4 hours
19. T-37 Egress -- Ground egress -- In-flight egress -- Ejection procedures	3 hours
20. Live Fire Ejection Seat	2 hours
21. Survival Medicine -- Bleeding -- Shock -- Injuries -- Exposure	1 hour
22. Psychology of Survival -- Conditions -- Fear -- Will to survive	1 hour
23. Survival Equipment and Procedures -- Equipment familiarization -- Procedures -- Travel	1.5 hours
24. Signaling -- Signaling procedures -- Manufactured signals -- Improvised signals -- Recovery procedures	1 hour
25. Course Review	1 hour
26. Examination and Critique	2 hours

The United States Air Force Refresher Training program is a required training for all aircrew with the courses divided by aircraft characteristics. The Tanker, Transport, and Bomber (TTB) course is separate from the Trainer, Attack, Reconnaissance, and Fighter (TARF) course. The course content is as follows:

Trainer, Attack, Reconnaissance, and Fighter (TARF) Refresher course

1. Physiological Stresses — 1 hour
   - -- Hypoxia
   - -- Hyperventilation
   - -- Pressure changes
   - -- Trapped gases
   - -- Evolved gases

2. Health and Wellness — 1 hour
   - -- Self medication
   - -- Diet and exercise

3. Human Factors — 1 hour
   - -- Situational awareness
   - -- Fighter aircrew personality traits

4. Mission Stresses — 2 hours
   - -- Acceleration
   - -- Spatial disorientation

5. Type V Chamber Flight — 2 hours

6. Examination and Critique — 1 hour

Tanker, Transport, and Bomber (TTB) Refresher course

1. Altitude Physiology Review — 1 hour
   - -- Hypoxia and hyperventilation
   - -- Trapped and evolved gas disorders

2. Situational Awareness — 1 hour
   - -- Attention traps
   - -- Aircrew coordination problems

3. Situational Disorientation Trainer — 1.5 hours

4. Aircrew Communication — .5 hour

5. Spatial Disorientation — 1 hour
   -- Sensory traps

6. Aircrew Fitness — 1 hour
   -- Stress
   -- Illness/self-medication
   -- Fatigue and circadian rhythm
   -- Thermal stress
   -- Alcohol and tobacco
   -- Diet and exercise

7. Type V Chamber Flight — 2 hours

8. Examination and Critique — 1 hour

The Civil Aeromedical Institute established its physiological training program in 1967 and provides aerospace physiology training for the general aviation population. The course they provide is as follows:

Civil Aeromedical Institute Physiological Training

1. Physics of the atmosphere
   -- Composition
   -- Methods of expressing altitude
   -- Physiological Divisions
   -- Physical Gas Laws

2. Respiration and Circulation
   -- Respiration
   -- Circulation

3. Hypoxia
   -- Forms of hypoxia
   -- Symptoms of hypoxia
   -- Effective performance time or time of useful consciousness
   -- Methods to combat hypoxia
   -- Oxygen requirements

4. Hyperventilation
    -- Symptoms and treatment

5. Decompression sickness
    -- Trapped gases - cause, effects, prevention, and treatment
    -- Evolved gases
    -- Scuba diving and flying

6. Cabin pressurization
    -- Advantages of pressurization
    -- Physiological effects of decompression

7. Principles and problems of vision
    -- Anatomy
    -- Illumination levels
    -- Instrument lighting
    -- Adverse weather lighting
    -- Thunderstorms

8. Noise and general aviation pilot
    -- Causes of noise
    -- Exposure and hearing loss
    -- Protection

9. Spatial disorientation
    -- Sensory systems involves
    -- Contributing flight factors
    -- Sensory and visual illusions
    -- Recovery procedures

10. Oxygen equipment
    -- Storage
    -- Regulators and masks
    -- Preflight inspection
    -- Oxygen Safety

11. Self-Imposed stress
    -- Alcohol
    -- Drugs
    -- Recommendations

12. Physical fitness
    - -- Diet
    - -- Rest
    - -- Exercise
    - -- Circadian rhythms

13. Survival
    - -- Psychological effects
    - -- Clothing
    - -- Food and water
    - -- Survival kits
    - -- Sources of information

14. Altitude chamber flight

CHAPTER III

METHODOLOGY

Introduction

This study investigated the current curriculum being presented to the student pilot in college or university aviation programs. The methodology of this study included the following: (1) the population; (2) data collection instruments; (3) collection of data; and (4) analysis of the data. The problem is that no summary or analysis has been made of what UAA member universities presently cover and perceive should be taught with regard to physiology in an aviation physiology education program. This information is needed to assist today's curriculum designers and developers.

Population

The population of this study was all of the 105 universities and colleges in the University Aviation Association (Appendix D) that provided flight instruction. The directors of aviation of all the 105 aviation training facilities were contacted and requested to complete a questionnaire concerning the following:

1. The current curriculum in their physiology program
2. The ideal physiology training program
3. The current physiological qualifications of the Certified Flight Instructors

4. The value of a physiological training program

Additionally, questionnaires will be sent to the same schools for students to complete and will include the following:

1. The level of physiological training.
2. If they have received hypobaric training.

Instrument

The instrument used for this study was a questionnaire developed by the researcher. The validity of the questionnaire was verified by three individuals, each an expert in his/her specialty.

Collection of Data

Construction of the Questionnaire

The questionnaire was the primary source of data. Interviews with the National Transportation Safety Board and Federal Aviation Administration Aviation Physiologists are secondary sources. The Federal Aviation Administration Physiological Training Handbook and the United States Air Force Physiological Training Program are considered tertiary sources of information. The validation of the questionnaire for content and consistency was completed by a review from the following: (1) an instructor in educational research, (2) a physiologist at the Oklahoma State University College of Osteopathic Medicine, and (3) the Federal Aviation Administration resident physiologist at CAMI. After the needed revisions were accomplished, the questionnaire was considered valid.

The final phase was an in-person visitation and interview by this writer to selected flight training sites to validate responses.

Design of the Questionnaire

Each questionnaire was accompanied by a letter of introduction outlining the purpose and importance of this survey. The questionnaire gathered data concerning the following general characteristics:

1. the current structure of instruction for aeromedical factors in UAA schools.
2. the UAA schools indicated level of necessity for instruction in aeromedical factors.
3. the UAA schools preferred subjects and method of aeromedical instruction.
4. the desired educational qualifications in an aeromedical factors instructor.

The questionnaire to the Aviation Coordinator appealed for his/her current curriculum and requested specific recommendations of course content and instructor qualifications. It also invited recommendations for the optimum training schedule for physiological training. Respondents were asked to return the completed questionnaires in the enclosed stamped and self-addressed envelopes.

Analysis

Upon completion and return of the questionnaires the responses were recorded in Microsoft Excel and Microsoft Access. The data were then summarized and responses from the population listed. Frequency counts were tabled for questions and percentages made from the total returned questionnaire population. A summary of the individual responses were listed. Tables listing the number of responses to the questionnaire and the recommendations were rank-ordered. Chart diagrams display the total responses of the various questions broken into those who favor and those who do not desire aeromedical factors training.

CHAPTER IV

RESULTS OF THE STUDY

The problem is that no summary or analysis has been made of what UAA member universities presently cover and perceive should be taught with regard to physiology in an aviation physiology education program. This information is needed to assist today's curriculum designers and developers. The first three chapters were a general introduction to the study, a review of related literature, and a discussion of the design of the study. This chapter is a presentation of the findings from the Oklahoma State University Survey of Aeromedical Factors in General Aviation. Data obtained from the questionnaire are discussed and analyzed.

The data are presented in two sections. The first section contains responses to the questionnaire items reflecting the current curriculum for aeromedical factors. Frequencies and percentages are concerned with:

1. the requirement for aeromedical factors.
2. the method of instruction.
3. the level at which the instruction is provided.
4. the subjects taught in aeromedical factors.
5. the number of course credit hours awarded for aeromedical factors.
6. the length of the course.

8. the textbook used to teach aeromedical factors.

9. the use of specialized aeromedical factors training equipment.

10. the requirement to attend a physiological training facility to complete aeromedical factors.

11. the distance to the nearest physiological training facility.

12. the determination of the level of perceived importance of aeromedical factors instruction.

The data in the second part are presented according to the research questions listed in Chapter I. Frequencies and percentages are concerned with:

1. The recommended subjects to be covered in an aeromedical factors course.

2. The recommendation to use or not use an altitude chamber as part of the aeromedical factors course.

3. The recommended altitude to use in an altitude chamber used as part of the aeromedical factors course.

4. The recommended college classification (level) of the student enrolled in aeromedical factors.

5. The recommended type of instruction instructor for aeromedical factors, e.g. faculty, CFI, AGI, or adjunct faculty.

6. The recommended educational qualifications desired in an aeromedical factors instructor.

Responses to the Questionnaire

A list of University Aviation Association Institutional Members was obtained from the University Aviation Association, 3410 Skyway Drive, Auburn, AL 36830. A questionnaire was mailed to each of the listed members. A total of 105 questionnaires were sent by first class mail on 10 September, 1994. A total of 63 questionnaires were returned. This represented a 60.0 percent return.

Research Question One

What is the current involvement of the University Aviation Association schools concerning instruction in Aeromedical Factors?

To obtain supporting data to this question, items one, two, three, four, and five were utilized. These items were: the requirement for Aeromedical Factors, the method of instruction, the level at which the instruction is provided, the subjects taught in aeromedical factors, the number of course credit hours awarded for aeromedical factors, the length of the course, the type instructor for the aeromedical course, the textbook used to teach aeromedical factors, the use of specialized aeromedical factors training equipment, the requirement to attend a physiological training facility to complete aeromedical factors, and the distance to the nearest physiological training facility.

To investigate the schools that include Aeromedical Factors instruction in the aviation education program, questionnaire item number one was used. Questionnaire data indicated that 80 percent of the respondents from the University Aviation Association required instruction in Aeromedical Factors (see Figure 1).

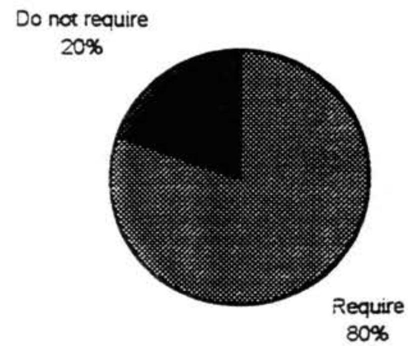

Figure 1. University Aviation Assocaiton Schools that Require Instruction in Aeromedical Factors

To determine the method of instruction for aeromedical factors, the second part of questionnaire item one was used. Questionnaire data indicated that 58 percent of the schools used a college course to teach Aeromedical Factors, 35 percent used a ground school course, 2 percent used a home study course, and 5 percent left this item unanswered (Figure 2).

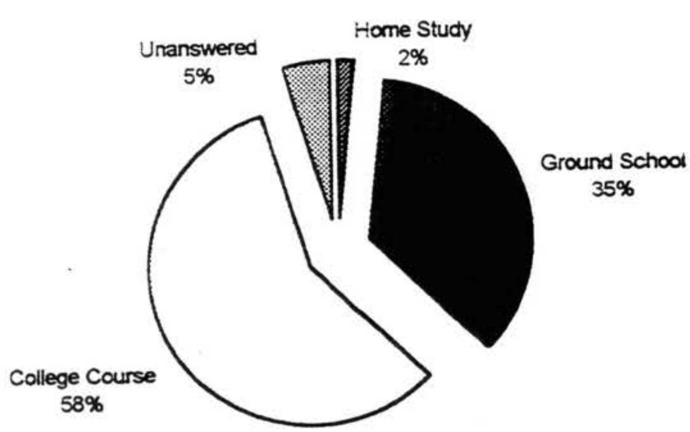

Figure 2. Method of Aeromedical Factors Instruction

Questionnaire item number two was used to determine if the University Aviation Association students were receiving formal course training in Aeromedical Factors and at what stage in their educational program. The results of the questionnaire also indicated that 63 percent of the schools provide formal course training in aeromedical factors and 37 do not provide any formal course instruction in this area (Figure 3).

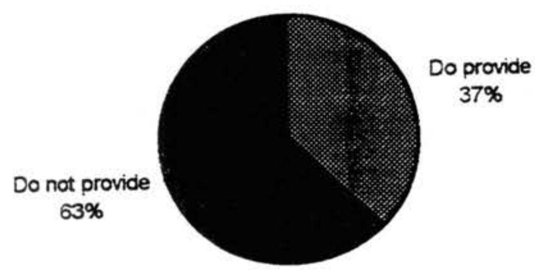

Figure 3. University Aviation Association Schools Providing Formal Aeromedical Factors Course

The level at which Aeromedical Factors was taught revealed that 32 percent were Freshman, 31 percent were Sophomore, 22 percent were Junior, 12 percent were Senior, and 3 percent were Graduate level students (Figure 4).

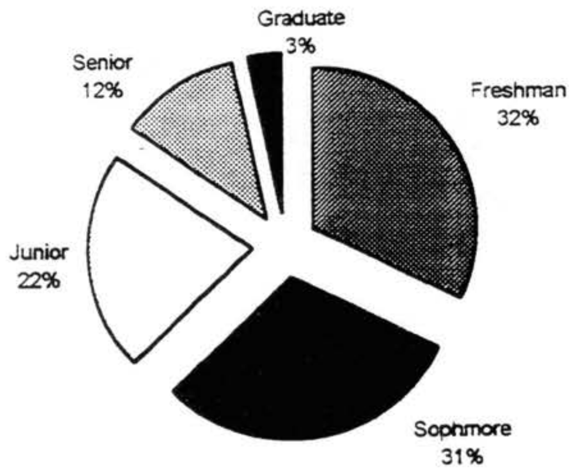

Figure 4. Level at Which Aeromedical Factors Is Taught

The respondents were asked in questionnaire item 2b to list the subjects they were currently teaching as part of their Aeromedical Factors course. The results are shown in Figure 5.

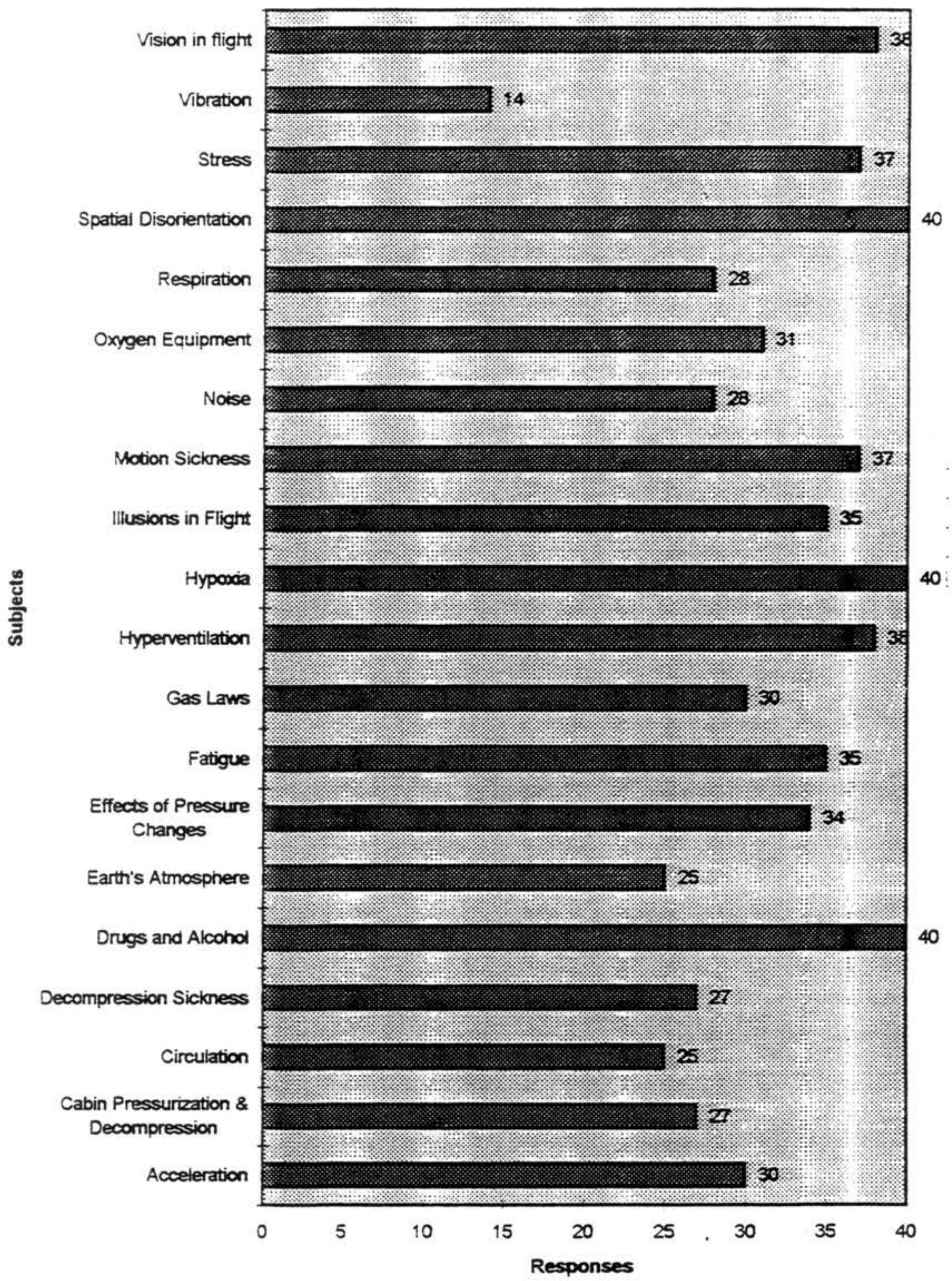

Figure 5. Subjects Taught by University Aviation Association Schools

To determine if college credit was awarded for the successful completion of an Aeromedical Factors course, item 2c was used. The survey revealed that of the respondents answering question 2c, 53 percent gave college credit for Aeromedical Factors courses and 47 percent did not give credit for these same courses (Figure 6). Those who awarded credit hours responded that 65 percent awarded 3 semester hours, 18 percent awarded 1 semester hour, 9 percent awarded 2 semester hours, and 4 percent awarded 4 semester hours credit (Figure 7).

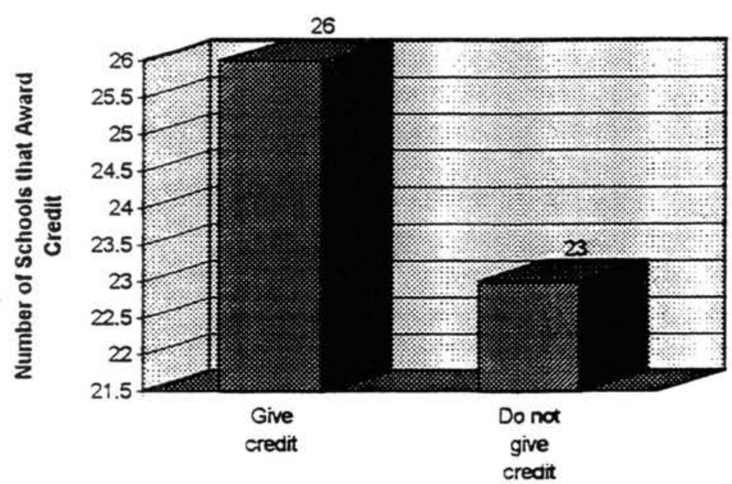

Figure 6. University Aviation Assocaition Schools that Award Credit for Aeromedical Factors Courses

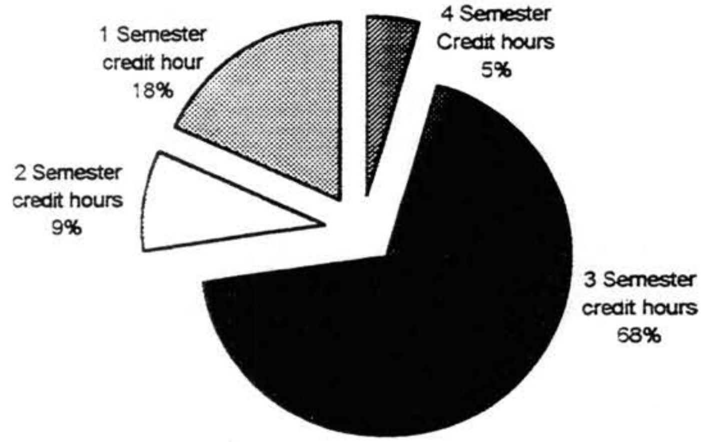

Figure 7. Credit Hours Granted for Aeromedical Factors by University Aviation Association Schools

To obtain knowledge on who was currently teaching Aeromedical Factors, item 2e was used. When queried as to the type of instructors used to teach Aeromedical Factors, the respondents indicated that 48 percent used faculty, 40 percent used Certified Flight Instructors, and 13 percent used adjunct faculty (Figure 8).

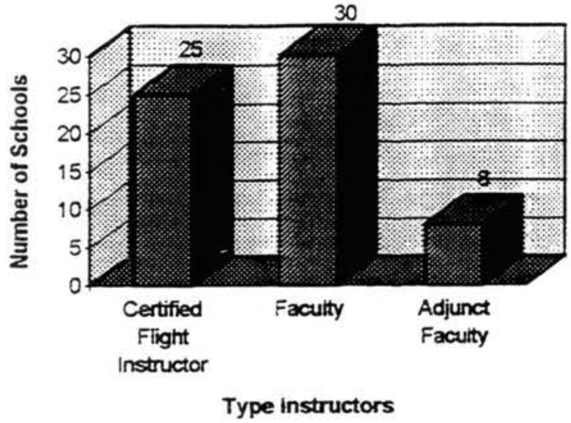

Figure 8. Type of Instructors Used to Teach Aeromedical Factors In UAA Schools

Questionnaire item 2f was used to determine if the Aeromedical Factors instructor had any specialized training. The survey indicated that 20 percent of the University Aviation Association instructors teaching Aeromedical Factors have received specialized training such as a physiologist and that the remaining 80 percent had no specialized training (Figure 9).

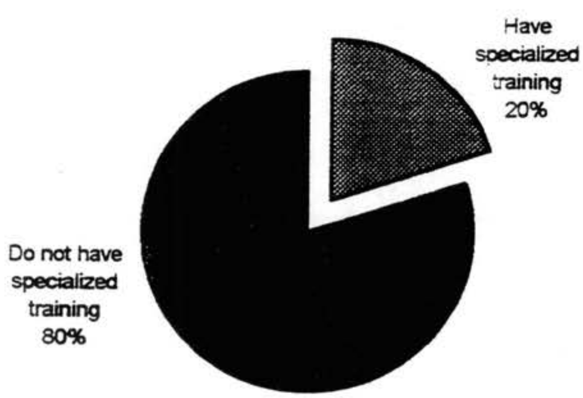

Figure 9. Instructors That Have Specialized Training In Aeromedical Factors

To investigate if a textbook was used to teach Aeromedical Factors, and the title of the textbook, questionnaire item 2g was used. The questionnaire requested the respondents indicate the textbooks currently used in the instruction of Aeromedical Factors. The responses varied as to the textbooks used (Table 1) and only 20 schools indicated that they used any textbooks (Figure 10).

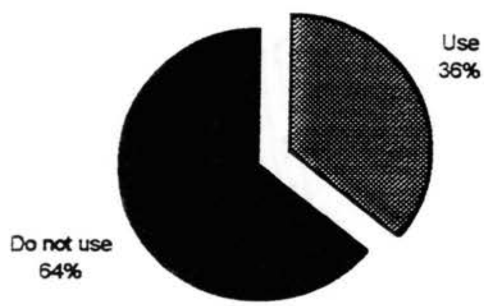

Figure 10. UAA Schools that Incorporate the Use of Textbooks in Aeromedical Factors

TABLE I

TEXTBOOKS USED FOR AEROMEDICAL FACTORS IN UNIVERSITY AVIATION ASSOCIATION SCHOOLS

Textbook	Number of Schools Using
Jeppesen-Sanderson Private Pilot and Instrument Manual	6
Basic Flight Physiology	6
Army Aeromedical Training Manual for Aviators	4
Air Force Physiological Training Manual	4
Human Factors for General Aviation	4
Federal Aviation Agency Physiological Training Manual	3
Human Factors in Flight	1
Human Anatomy and Physiology	1
Aviation Medicine	1
Modern Airmanship	1
Aerospace Fundamental	1
Federal Aviation Agency Flight Training Handbook	1
Airman's Information Manual	1

Questionnaire item number 3 was used to determine the use of aeromedical training equipment in the University Aviation Association schools. The use of additional training equipment to augment the Aeromedical Factors course was incorporated into the course by 27 percent of the University Aviation Association schools, whereas 83 percent did not use any additional training devices (Figure 11).

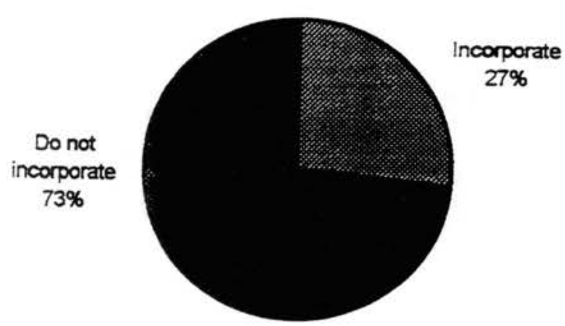

Figure 11. Schools that Incorporate the Use of Aeromedical Training Equipment

The specialized training equipment used to augment the Aeromedical Factors course was surveyed in the second part of item 3. The questionnaire responses indicated that two schools had their own hypobaric chamber, 6 schools had spatial disorientation trainers, 3 had an oxygen laboratory, 11 had a Barany chair, 2 had a night vision trainer, and 1 had a vision lab. Responses on the survey indicated that 5 schools used hypobaric chambers at neighboring military installations, federal installations, or universities (Figure 12).

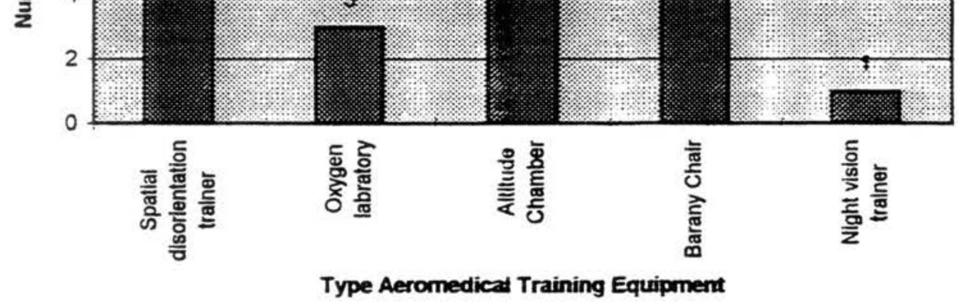

Figure 12. Number of UAA Schools Using Aeromedical Training Equipment

To investigate the amount of importance placed by the participants on additional aeromedical factors training item 4 of the questionnaire was used. The results of this item concerning the requirement of a military, federal, or other physiological facility to augment aeromedical training indicated that 72 percent encourage, 26 percent do not require, and 2 percent required such training (Figure 13).

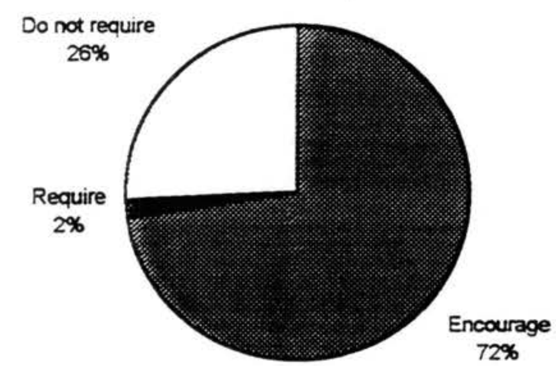

Figure 13. UAA Schools Requiring Military, Federal, or Other Physiological Training Facility to Augment Aeromedical Training

The response to the question concerning the distance to the nearest physiological training facility revealed that 36 percent are within 100 miles, 25 percent are between 101 to 200 miles, 8 percent are between 201 to 300 miles, 3 percent are between 301 to 400 miles, 2 percent are between 501 to 600 miles, and 25 percent are uncertain of the distance. (Figure 14).

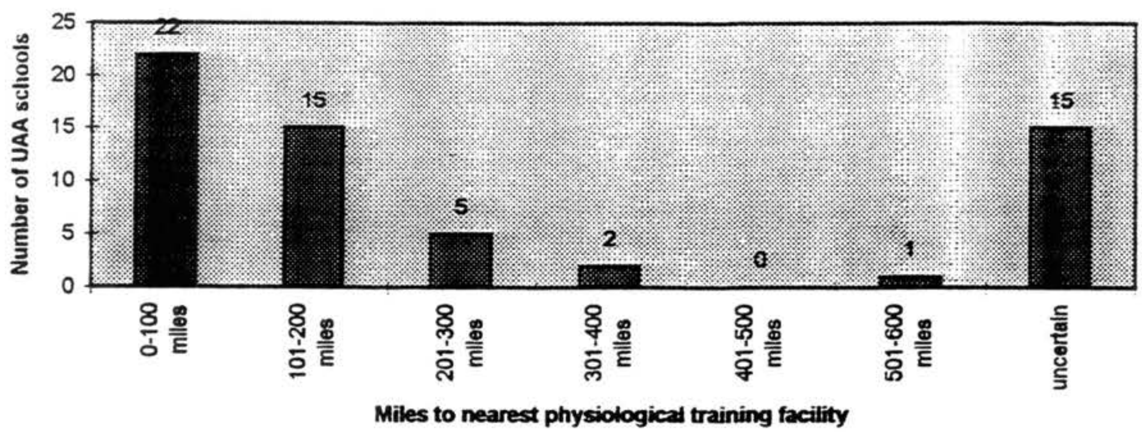

Figure 14. Distance from the Nearest Physiological Training Facility

To rate the importance of aeromedical factors in University Aviation schools, item 6 was used. The questionnaire polled each University Aviation Association school for their opinion on the importance of aeromedical factors instruction for the aviation student. All respondents answered this question with the following results: no one reported below necessary on a likert scale, 11 percent indicated it was necessary (5), 3 percent indicated it as slightly above necessary (6), 9 percent indicated it a little more important (7), 25 percent indicated it as even more important (8), 16 percent indicated it was still more important (9), and 36 percent indicated it was absolutely necessary (10) (Figure 15).

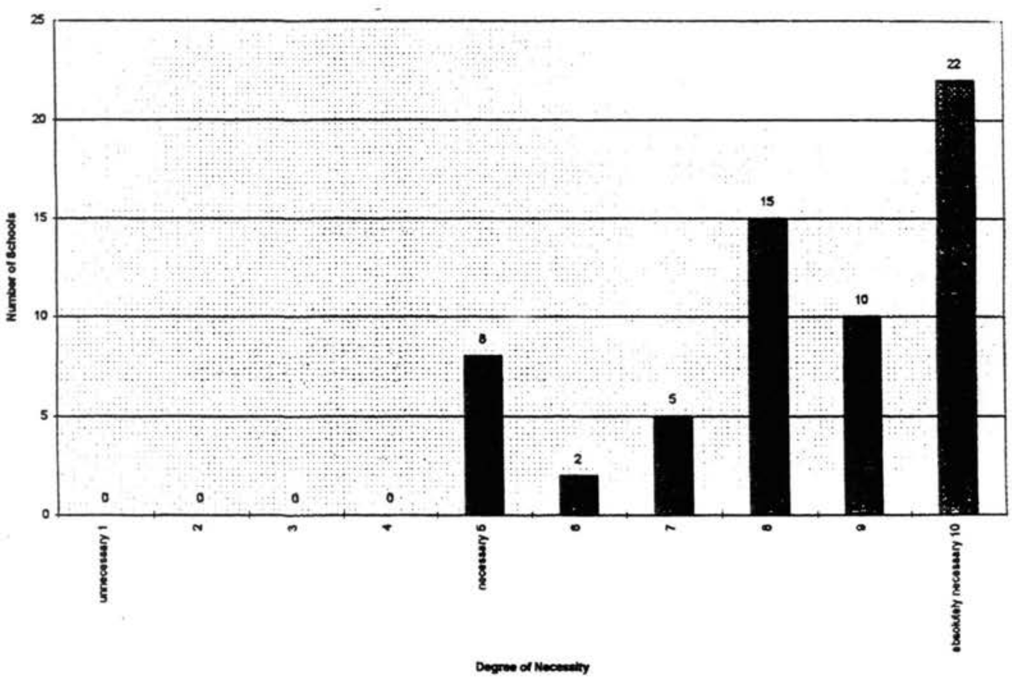

Figure 15. UAA Schools Perception As To the Degree of Necessity for Aeromedical Factors Instruction

Research Question Number Two

If given unlimited resources, what would the University Aviation Association schools determine to be an optimum training program?

Considered in these items were: the subjects to be covered in an aeromedical factors course, to use or not use an altitude chamber as part of the aeromedical factors course, the altitude to use in an altitude chamber used as part of the aeromedical factors course, the college classification (level) of the student enrolled in aeromedical factors, the type of instructor for aeromedical factors, and the educational qualifications desired in an aeromedical factors instructor.

To determine the subjects to be included in an Aeromedical Factors course, item 7 was used. The respondents indicated that several subjects were of equal or near equal importance. The most often selected subjects were hypoxia, hyperventilation, spatial disorientation, stress, drugs and alcohol, fatigue, vision in flight, illusions in flight, and motion sickness. Hypoxia, hyperventilation, spatial disorientation, and illusions in flight were selected as the top 5 (1-5) choices for all the schools responding. The second most popular group of subjects were drugs and alcohol, vision in flight, fatigue, and stress. The second group was selected as the second group of the five most popular choices (6-10) among all the respondents. The third most popular group (11-15) included cabin pressurization, decompression sickness, noise, acceleration, oxygen equipment , and earth's atmosphere. The last group (16-20) indicated a rapid falling in response rate. Only 15 or less of the respondents indicated the following should be included in the course subjects: respiration, gas laws, effects of pressure change, vibration, and circulation (Figure 16).

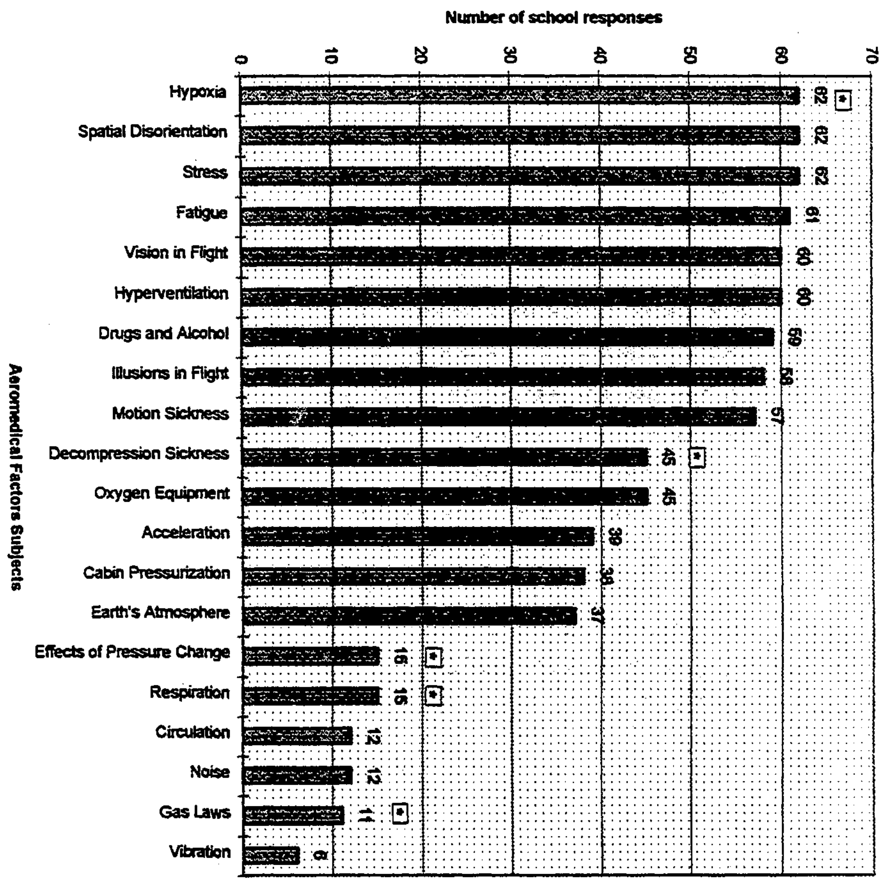

Figure 16. Aeromedical Factors Subject Preference

Note: * denotes the subjects that FAR 61.31(F)(1)(i) requires to be taught for high altitude airplanes.

To determine if the University Aviation Association schools would incorporate an altitude chamber in their Aeromedical Factors course, item 8 was used. The survey indicated that 71 percent of the University Aviation Association schools would incorporate the use of an altitude chamber, 8 percent would not incorporate the use of an altitude chamber, and 21 percent were uncertain if they would incorporate the use of an altitude chamber if they had unlimited funding (Figure 17).

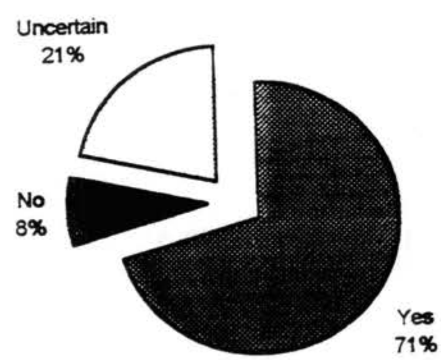

Figure 17. Percentage of UAA Schools that Would Include Training in An Attitude Chamber

The participants that would incorporate an altitude chamber in their training program were asked what altitude they preferred to use in their training. This was determined in the second part of item 8. The most frequent response was 35,000 feet (40 percent), 21 percent selected 30,000 feet, 28 percent selected 25,000 feet, 9 percent selected 20,000 feet, and 2 percent selected 15,000 feet (Figure 18).

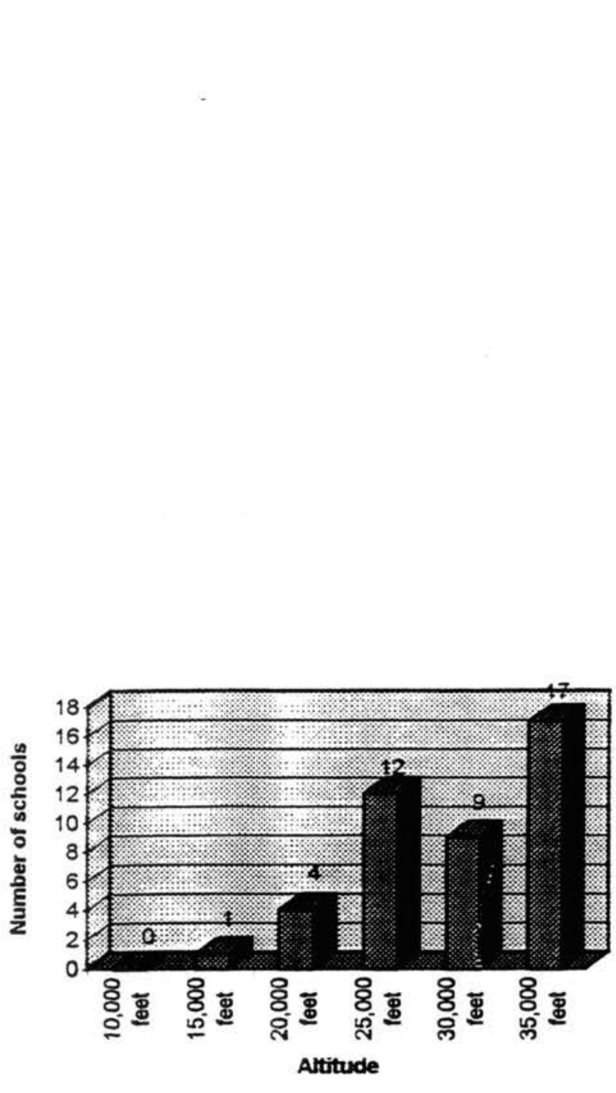

Figure 18. Altitude Limit Preferred for Physiological Training

The questionnaire asked the participants the preferred level of education to teach Aeromedical Factors. Findings showed that the most often selected level at which instruction is preferred to be given is the Junior year of school. Sixteen participants selected multiple years for this type of education and 9 indicated that the aeromedical education was an evolutionary education starting at the Freshman year and continuing through the Senior year. The need for graduate education was limited to three participants selecting this option, however, all three also selected Sophomore and Junior years as well (Figure 19).

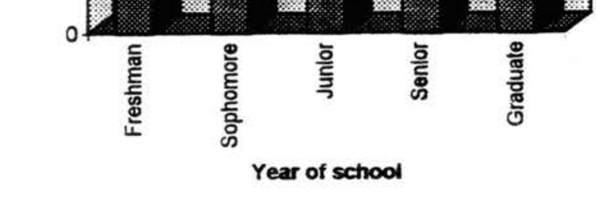

Figure 19. Preferred Educational Level to Teach Aeromedical Factors

To obtain knowledge concerning the best person qualified to provide instruction in Aeromedical Factors, item 10 was used. The University Aviation Association schools were asked to select the best qualified person to teach aeromedical factors. Faculty were chosen by 39 percent, adjunct faculty was selected by 22 percent, aeromedical specialist was selected by 22 percent, and Certified Flight Instructor was selected by 17 percent (Figure 20).

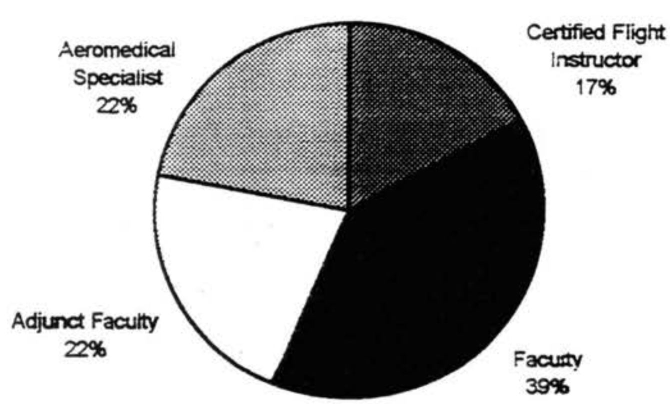

Figure 20. Type Instructor Preferred to Teach Aeromedical Factors

The survey indicated that the participants felt that the best qualified instructor to teach Aeromedical Factors would be a military trained physiologist. Military physiologist was selected by 49 of the participants, Doctor of Medicine was selected by 42 of the participants, and a Certified Flight Instructor was selected by 30 of the participants (Figure 21).

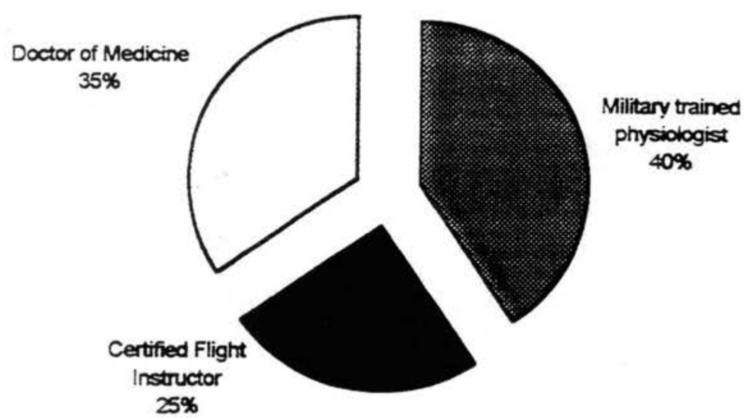

Figure 21. Desired Qualifications for an Aeromedical Factors Instructor

To investigate what the University Aviation Association schools considered to be an optimum aeromedical training program, item 11 was used. Item 11 on the survey also requested each participant provide any comments concerning this subject. Some of the selected comments were:

> If it were possible to have access to a hypobaric chamber for all to experience during the 3 semester hour course, it would be excellent. What we are using presently is a home-made Barany chair which works great for spatial disorientation.
>
> As coordinator of a two-year aviation community college, an aeromedical training program would be nice to have - but difficult to put in to an already tight curriculum. I would prefer a course specifically on medical facts - including a chamber ride.
>
> Aeromedical training should be an integral part of flight training with an introduction at the private level as required by Federal Aviation Regulations. The students looking at professional flying should take a formal course, including chamber flights, as they progress to more advanced FAA ratings. Aeromedical factors are required in certain Part 141 requirements, but should be re-emphasized in Human Factors and Safety courses for all aviation majors.
>
> Three units of human anatomy and physiology and three units of aeromedical training encompassing the subject areas covered in item #7 of the survey.
>
> An optimum aeromedical factors course would consist of part lecture and part laboratory experiences. This subject is a good candidate for graduate study.
>
> The course should follow the outline in the Jeppesen text, augmented by using an altitude chamber, Barany chair, night vision demonstration, and taught by an MD.
>
> Students need to be exposed to aeromedical issues pertaining to flight physiology -- the extent and content to aid in accident prevention. Since most pilots trained through the colleges and universities will not be piloting high performance aircraft for some time, extensive training in all aspects of aeromedical issues is only of value to those that have graduate programs and/or the luxury of staff or dollars donated to the subject. Smaller schools must include the subject in other courses, i.e. Aviation Safety, Basic, Advanced, Instrument, Commercial, and Certified Flight Instructorground schools.

While it is important for our students to have this information, their limited background and training precludes more sophisticated coursework. As one moves into multi-engine and jet equipment, I feel there is a definite need for an aeromedical course at the Junior or Senior year.

I believe that one course (3 hours) in the subject along with a visit to an altitude chamber and an experience in the vertigo chair would suffice.

The curriculum needs to include hypoxia, spatial disorientation, and illusions during flight. This is best accomplished with lectures on those subjects and with a lab follow-up including an altitude chamber, night flight, and purposeful disorientation during flight with a qualified flight instructor.

I believe that this kind of training should be carefully planned so as to be as unintimidating, informal, interesting, clearly related to actual everyday flying and free of specialized medical and physiological terms as possible. I find that most pilots endure instruction in aeromedical factors sufficiently to pass the formal test. Most seem to be scoffing and antagonistic toward the subject, and reject it as something that the government is imposing on them or that it will never happen to them.

I would like to have a simulator lab for demonstrating to each student the effects on that student personally of fatigue, stress, alcohol, drugs, and other sources of distraction from the acts of flight planning and preparation, and of piloting. I believe that most "accidents" result from distractions and inattention. Each of the factors listed in item 7 is a factor only because it distracts the pilot in some way or physically prevents the pilot from performing effectively.

A five hour (quarterly) academic course in flight physiology, approximately 50 hours of contact time.

I favor distributing the coverage of aeromedical factors throughout the curriculum. A dedicated course in flight physiology treating the subject on an advanced level would be best at the Junior or Senior level. An altitude chamber flight in conjunction with this class would be ideal. However, the FAA process for getting slots into military flight chambers makes it near impossible to take a group to the chamber.

There should be more focus placed on aeromedical factors, however, practical application is also a necessary component. We must be careful to not go into too much depth.

There is a need for a graduate level course to prepare the Certified Flight Instructor, Aviation Ground Instructor, and faculty to teach physiology to their students.

Additionally, 12 of the participants comments in item 11 of the survey referred to the military physiological training, combined with an altitude chamber, as being the optimum program that could be integrated into the curriculum. The majority of the participants, 34, felt that the subjects listed in item 7 of the survey were the items to be included in a course concerning aeromedical factors.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The purpose of this study was to determine the current methodology of aeromedical factors instruction in University Aviation Association schools and to ascertain a consensus of opinion on a recommended course of aeromedical instruction. The problem is that no summary or analysis has been made of what UAA member universities presently cover and perceive should be taught with regard to physiology in an aviation physiology education program. This information is needed to assist today's curriculum designers and devleopers. The questionnaire was designed to answer specific questions concerning various aspects of the higher educational level of instruction in Aeromedical Factors.

The participants in this study were members in the University Aviation Association. This group was selected to participate in this study because of the impact they have on the aviation community, especially in higher education. The purpose of the University Aviation Association, as written in the by-laws, is the development and advancement of aviation education; and to promote, encourage, or foster any athletic, charitable, benevolent, or eleemosynary purpose or activity. The objectives of the

University Aviation Association, as written in their by-laws, are: to encourage and promote the attainment of the highest standards in aviation education at the college level; to provide a means of developing a cadre of aviation experts who would be available for such activities as consultation, aviation program evaluation, speaking assignments, and other professional contributions that would tend to stimulate and develop aviation education in all of its phases; to furnish a national vehicle for the dissemination of intelligence relative to aviation between institutions of higher education and governmental and industrial organizations in the aerospace field; to permit the interchange of information between institutions that offer aviation programs that are non-engineering oriented.

A questionnaire was developed, validated, and disseminated to gather data from the various schools in the University Aviation Association. The questionnaires were mailed to all 105 of the institutional members in the University Aviation Association by first class mail on 10 September, 1994. Included in each questionnaire packet was an instruction sheet, a cover letter encouraging participation in the survey that was co-signed by the Aviation and Space Education department head, and a stamped envelope in which to return the questionnaire. Of the 105 institutional members in the University Aviation Association, 63 questionnaires were returned and were suitable for data interpretation.

Upon receiving the returned questionnaires, the data were extrapolated from each questionnaire and entered into a data base. Microsoft Approach and Microsoft Excel were used to compile data and generate the graphs and charts. Frequency counts were tabulated for each question and percentages were made for the total returned questionnaire population. Because of the representative data, it was determined to directly report the data without the use of statistical inferences.

The following research questions were discussed:

1. How involved is the University Aviation Association schools in the instruction of Aeromedical Factors?

2. If given unlimited resources, what optimal training program would University Aviation Associationschools implement?

Findings

Based on the findings of the study, the evidence supports the following conclusions:

1. The majority (80%) of the responding University Aviation Association schools currently require instruction in Aeromedical Factors.

2. The preferred method of instruction for Aeromedical Factors is a college academic course.

3. Over 63 percent of the schools do not provide a separate formal Aeromedical Factors course.

4. The current level at which Aeromedical Factors is taught is 32 percent at the Freshman level, 31 percent at the Sophomore level, 22 percent at the Junior level, 12 percent at the Senior level, and three percent at the Graduate level.

5. The most often taught subjects in University Aviation Association schools are vision in flight, spatial disorientation, hypoxia, hyperventilation, and drugs and alcohol.

6. Only 26 (53%) of the 49 respondents awarded college credit for Aeromedical Factors courses. Of those who awarded college credit, 68 percent awarded three credit hours for completion of the Aeromedical Factors course.

7. The type of instructor used to teach Aeromedical Factors was most often (48%) a faculty member. Of those that taught Aeromedical Factors only 20 percent had specialized training in this area.

8. Only 35 percent of the participants incorporated any kind of specialized equipment to augment the Aeromedical Factors course.

9. Seventy-two percent of the responding University Aviation Association Schools encourage the use of an outside physiological training facility, whereas only two percent require use.

10. Fifty percent of the University Aviation Association schools that responded knew the distance to the nearest physiological training facility was within 100 miles.

11. One hundred percent of the University Aviation Association schools that responded deemed instruction in Aeromedical Factors as "necessary" or higher. Thirty-six percent believed that instruction in Aeromedical Factors was "absolutely necessary."

12. Preferred subjects in an Aeromedical Factors course include: hypoxia, hyperventilation, spatial disorientation, stress, fatigue, vision in flight, drugs and alcohol, and motion sickness.

13. Seventy-one percent of the participants would include the use of an altitude chamber if they had unlimited funds.

14. The preferred altitude to use in altitude training is 35,000 feet.

15. The desired educational level to teach Aeromedical Factors is the Freshman, Sophomore, and Junior levels.

16. Faculty were selected by 37 percent to teach Aeromedical Factors and an aeromedical specialist was selected by 22 percent.

17. The desired qualifications in an aeromedical factors instructor is the military trained physiologist and was selected by 40 percent of the participants.

Conclusions

The study assessed the curriculum requirements for Aeromedical Factors in University Aviation Association schools. The survey also indicated the necessity for improving the Aeromedical Factors courses offered at University Aviation Association schools.

The findings of the survey identified that little standardization exists concerning course content, textbooks, instructors, and facilities. A large variation exists in the structure and implementation from school to school concerning instruction in Aeromedical Factors.

Only two schools in the University Aviation Association offer a complete course in Aeromedical Factors: the University of North Dakota and Oklahoma State University. Training at these schools includes altitude chamber orientation and high altitude flight physiology certification. Oklahoma State University also offers two graduate courses in Aeromedical Factors that are designed to provide Aeromedical Factors training for the Certified Flight Instructor, Advanced Ground Instructor, and aviation educators.

Current Federal Aviation Regulations stipulate the type of training required for various aviation certificates. These regulations, however, do not indicate who should teach aeromedical factors or the use of additional equipment to augment training in this area.

The review of National Transportation Safety Board historical data supports the need for improved aeromedical factors training for all aircrew members, especially pilots. The Aviation Safety Reporting System data also indicate a need for more formal education and advanced training concerning this subject.

Recommendations

Based on the findings and conclusions of this study, the following recommendations are made:

1. Modification of existing Aeromedical Factors training curricula is warranted and should include education on subjects required by the Federal Aviation Agency and other required subjects. The subjects taught in an aeromedical factors course should include: Hypoxia, hyperventilation, spatial disorientation, illusions in flight, drugs and alcohol, vision in flight, fatigue, stress, cabin pressurization, decompression sickness, noise, acceleration, oxygen equipment, the atmosphere, respiration, gas laws, effects of pressure change, vibration, and circulation.

2. Aeromedical Factors curricula at the various University Aviation Association schools should be standardized and should include an indoctrination in an altitude chamber. Altitude chamber training conducted at military instillations should be considered as the standard for general aviation aircrew and pilots.

3. Provide advance/specialized Aeromedical Factors training for the Certified Flight Instructor, Advanced Ground Instructor, and faculty that teach Aeromedical Factors.

4. University Aviation schools that are near a military, federal, or civilian physiological training facility should take advantage of the training opportunity and make attitude chamber and spatial orientation training a part of the syllabi for the Aeromedical Factors course. Those schools that are not close to such a facility should attempt to make arrangements for an extended class trip to take advantage of the added educational benefit of attitude chamber training.

5. Increase the emphasis placed on Aeromedical Factors training in University Aviation Association schools. Make Aeromedical Factors a mandatory course for all students pursuing the professional pilot option in University Aviation Association schools.

6. Teach different aspects of aeromedical factors as early as possible in the aviation students flight education. Teach a formal Aeromedical factors course in the junior year.

Recommendations for Future Research

1. In order to provide highly qualified Aeromedical Factors instructors, a comprehensive analysis of the educational expertise required for these instructors should be investigated.

2. A more detailed analysis concerning the different curriculum requirements and capabilities for Aeromedical Factors should be made between two-year and four-year University Aviation Association schools.

3. A survey concerning aeromedical factors teaching philosophy, methods, and desired outcomes of all the aviation schools in the United States should be made to

establish a comprehensive database that would establish a universal training program on Aeromedical Factors.

The purpose of this study has been to describe the current practices, the perceived need, and an optimum aeromedical factors training program for University Aviation Association schools. This information will help University Aviation Association schools in the future to identify current practices and proposed instructional methods. The University Aviation Association schools may wish to consider adoption of additional subjects and training methods as identified in the survey.

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APPENDIXES

APPENDIX A

AETC STUDY GUIDE/WORKBOOK

AETC STUDY GUIDE/WORKBOOK P-V4A-A-AP-SW/S-V8N-C-CAP-SW

UNDERGRADUATE FLYING TRAINING

AEROSPACE PHYSIOLOGY

JULY 1993

AIR EDUCATION & TRAINING COMMAND

DESIGNED FOR AETC COURSE USE

CONTENTS

CONTENTS

NOTE — Aerospace Physiology (T-1A) is listed in AETC Syllabus P-V4A-G. The course title is P-V4A-G-PH. This course contains lessons for T-1A Aerospace Physiology Review, Aircraft Pressurization, Oxygen Equipment, T-1A Egress (Life Support), and Type II Hypobaric Chamber flight and Rapid Decompression.

UPT/SUPT COURSE REQUIREMENTS (NOTE 1)

Lesson	*Title*	*Page*	*Hours*
AP0101	Course Introduction and the Atmosphere	1-1	1.0
AP0102	Respiration and Circulation	2-1	1.0
AP0103	Hypoxia and Hyperventilation	3-1	2.0
AP0104	Effects of Pressure Change	4-1	1.0
AP0105	Self-imposed Stress	5-1	2.0
AP0106	Situational Awareness	6-1	1.0
AP0107	Acceleration and G Forces	7-1	2.0 (1)
AP0108	Noise and Vibration	8-1	1.0
AP0109	Vision	9-1	2.0
AP0110	Spatial Disorientation	10-1	4.0 (1)
AP0111	Oxygen Equipment	11-1	2.0
AP0112	Type I Hypobaric Chamber Flight	13-1	2.0 (2)
AP0113	Type IV Hypobaric Chamber Flight	15-1	1.0 (1)
AP0114	AP Block I/Documentation Only (NOTE 2)		
AP0115	The Parachute	16-1	1.5
AP0116	Descent and Landing Techniques	17-1	4.0
AP0117	Parachute Familiarization Training (NOTE 3)	18-1	4.0 (1)
AP0118	AP Block II/Documentation Only (NOTE 3)		
AP0119	T-37 Egress	19-1	3.0 (1)
AP0120	Live Fire Ejection Seat	20-1	2.0
AP0121	AP Block III/Documentation Only (NOTE 4)		
AP0122	Survival Medicine	23-1	1.0
AP0123	Psychology of Survival	24-1	1.0
AP0124	Survival Equipment and Procedures	25-1	1.5
AP0125	Signaling	26-1	1.0
AP0126	AP Block IV/Documentation Only (NOTE 5)		
AP0127	Course Review	27-1	1.0
AP0190	Examination and Critique	28-1	2.0
AP0128	Airsickness Management Program	29-1	0.5
AP0129	Human Factors and Acceleration	30-1	1.0
	Total Hours (T-37)		45.5 (7)

UPT/SUPT COURSE REQUIREMENTS (NOTE 1)

Lesson	*Title*	*Page*	*Hours*
AP0601	T-38 Physiology and Human Factors Review	31-1	1.5
AP0602	Aircraft Pressurization	12-1	0.5
AP0603	T-38 Oxygen Equipment	32-1	0.5
AP0604	T-38 Egress	33-1	3.0 (1)
AP0605	Type II Hypobaric Chamber Flight and Rapid Decompression	14-1	2.0 (2)
AP0606	AP Block V/Documentation Only (NOTE 6)..............		
	Total Hours (T-38)		7.5 (3)
	Total Hours		53.0 (10)

NOTE 1 — Selected portions of this course are taught by enlisted instructors. Specific guidance is provided by AFR 50-27, Air Force Aerospace Physiological Training Program and by the unit instructor guide. Additional time is authorized in designated instructional units, as indicated in parentheses in the "Hours" column. This time must be allocated when scheduling large classes and should also be used to complete individual practice.

NOTE 2 — AP0101 through AP0104 and AP0111 must be completed prior to AP0112 and AP0113. Complete AP0101 through AP0113 prior to first T-37 sortie, and update TRIM by annotating AP0114 as complete. The examination and critique may be administered without student(s) completing the chamber flight(s). However, chamber flight(s) deficiency must be documented and the student's flight commander must be notified.

NOTE 3 — AP0115 and AP0116 must be completed prior to AP0117. Complete AP0117 prior to graduation from Phase II. Make every effort to accomplish this training in Phase I. Update TRIM by annotating AP0118 as complete.

NOTE 4 — Complete AP0115, AP0116, AP0119 and AP0120 prior to first T-37 sortie. Update TRIM by annotating AP0121 as complete.

NOTE 5 — Complete AP0122 through AP0125 prior to first T-37 sortie. Update TRIM by annotating AP0126 as complete.

NOTE 6 — Complete AP0601 through AP0605 prior to first T-38 sortie. Update TRIM by annotating AP0606 as complete.

SUNT COURSE REQUIREMENTS (NOTE 1)

NOTE 1 — Selected portions of this course are taught by enlisted instructors. Specific guidance is provided by AFR 50-27, Air Force Aerospace Physiological Training Program and by the unit instructor guide. Additional time is authorized in designated instructional units. as indicated in parentheses in the "Hours" column. This time must be allocated when scheduling large classes and should also be used to complete individual practice.

NOTE 2 — Complete CAP01 through CAP14, CAP20 through CAP27, and the examination prior to first T-43 sortie. The examination and critique may be administered without student(s) completing the chamber flight(s). However, chamber flight(s) deficiency must be documented and the student's flight commander must be notified.

NOTE 3 — Complete CAP15, CAP16, CAP18 and CAP19 prior to first T-37 sortie.

NOTE 4 — Complete CAP17 prior to graduation from Core Navigator Training. Make every effort to accomplish this training during Core Aerospace Physiology.

APPENDIX B

PHYSIOLOGICAL TRAINING- 1990

PHYSIOLOGICAL

TRAINING

1990

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
MIKE MONRONEY AERONAUTICAL CENTER
CIVIL AEROMEDICAL INSTITUTE
AIRMAN EDUCATION BRANCH

FOREWORD

Aviation Physiology deals with the physical and mental effects of flight on air crew personnel and passengers. Study of this booklet will familiarize you with some of the physiological problems of flight, and will instruct you in the use of some devices that Aviation Physiologists and others have developed to assist in the compensation for the numerous environmental changes that are encountered in flight.

For most of you, Aviation Physiology may be an entirely new field. To others, it is something that you were taught while in the military service or elsewhere.

It is our sincere hope that we can enlighten, stimulate, and assist you during your brief stay with us. After you have returned to your regular routine, remember that the Airman Education Branch of the Civil Aeromedical Institute strives to assist with problems concerning Aviation Physiology.

Inquiries should be addressed to:

Mike Monroney Aeronautical Center
Civil Aeromedical Institute
Airman Education Branch, AAM-420
P.O. Box 25082
Oklahoma City, Oklahoma 73125

Phone: (405) 680-4837
FTS: 747-4837

INTRODUCTION TO PHYSIOLOGICAL TRAINING

Humans have a remarkable ability to adapt to their surroundings. The human body makes adjustments for changes in external temperature, acclimates to barometric pressure variations from one habitat to another, compensates for motion in space and postural changes in relation to gravity, resists toxic agents and diseases, and performs all these adjustments while meeting changing energy requirements for varying amounts of physical and mental activity. The human body does adjust to acute and chronic reductions in its' oxygen supply by increasing respiration, chemical changes in the blood, and by increasing production of red blood cells; however, a complete absence of oxygen will cause death in approximately five to eight minutes.

In aviation, the demands upon the compensatory mechanisms of the body are numerous and of considerable magnitude. The environmental changes of greatest physiological significance involved in flight are: marked changes in barometric pressure, considerable variation in temperature, and movement at high speed in three dimensions.

The advances in aeronautical and mechanical engineering in the past decade have resulted in the development of highly versatile aircraft. Since we are essentially ground creatures, we must learn how to adjust to the low pressures and temperatures of flight, and the effects of acceleration on the body. Low visibility with its concomitant problems of disorientation, and problems related to the general physical and mental stress associated with flight, should also be considered. Humans cannot operate these machines at full capacity without physical aids, such as a supplemental supply of oxygen and pressurized cabins for use at altitudes starting as low as 10,000 feet.

We must overcome the handicaps imposed by nature on an organism designed for terrestrial life. In particular, the limiting factors in adjustment of the human body to flight must be appreciated. The extent to which these limiting factors are alleviated by available equipment must be understood clearly. Indifference, ignorance, and carelessness can nullify the foresight, ingenuity, and effort involved in supplying the pilot with efficient equipment.

An effort is made in the following pages to outline some of the important factors regarding physiological effects of flight, and to describe the devices and procedures that will contribute to the safety and efficiency of all who fly.

CONTENTS

PHYSIOLOGICAL TRAINING

APPENDIX C

CORRESPONDENCE

Battelle

ASRS Office
625 Ellis Street
Suite 305
Mountain View, California 94043
Telephone (415) 969-3969

April 18, 1994

Mr. David Conway
Oklahoma State University
300 North Cordell
Stillwater, OK 74078-0422

Dear Mr. Conway:

SEARCH REQUEST NO. 3419: "HYPOXIA OR HYPERVENTILATION REPORTS"

In response to your request of NASA's Aviation Safety Reporting System, enclosed is a printout of 58 reports referencing hypoxia or hyperventilation incidents. Attached is an explanation of the coded information contained in your printout.

At the time of this search, the ASRS database contained 46,798 full-form records received since January 1, 1986. There were also 117,772 abbreviated-form records in the database, but since incidents involving the above-mentioned topic are not identifiable in these records, they were excluded from the search.

Please bear in mind that the ASRS reports are soft data. The reports are submitted voluntarily and are subject to self-reporting biases. Such incidents, in many cases, have not been corroborated by the FAA or NTSB.

We hope you find this information useful for your purposes. Please note with care the attached caveat regarding statistical use of ASRS information and the point Mr. Reynard makes in his covering memorandum to recipients.

We would appreciate any comments you have regarding the value of this service. If you have any questions or comments, please do not hesitate to contact us at (415) 969-3969.

Sincerely,

Danielle Theriault
ASRS Database Specialist

Vincent J. Mellone
ASRS Deputy Program Manager

DT

Enclosures

National Aeronautics and
Space Administration
Ames Research Center
Moffett Field, CA 94035-1000

Reply to Attn of: FL:262-1

MEMORANDUM FOR: Recipients of Aviation Safety Reporting System Data

SUBJECT: Data Derived from ASRS Reports

The attached material is furnished pursuant to a request for data from the NASA Aviation Safety Reporting System (ASRS). Recipients of this material are reminded of the following points which must be considered when evaluating these data.

ASRS reports are submitted voluntarily. The existence in the ASRS database of reports concerning a specific topic cannot, therefore, be used to infer the prevalence of that problem within the national aviation system.

Reports submitted to ASRS may be amplified by further contact with the individual who submitted them, but the information provided by the reporter is not investigated further. Such information may or may not be correct in any or all respects. At best, it represents the perception of a specific individual who may or may not understand all of the factors involved in a given issue or event.

After preliminary processing, all ASRS reports are deidentified. There is no way to identify the individual who submitted a report. All ASRS records systems are designed to prevent any possibility of identifying individuals submitting, or other names, in ASRS reports. There is, therefore, no way to verify information submitted in an ASRS report after it has been deidentified.

The National Aeronautics and Space Administration and its ASRS contractor, Battelle Memorial Institute, specifically disclaim any responsibility for any interpretation which may be made by others of any material or data furnished by NASA in response to queries of the ASRS database and related materials.

William Reynard, Director
Aviation Safety Reporting System

CAVEAT REGARDING STATISTICAL USE OF ASRS INFORMATION

Certain caveats apply to the use of ASRS statistical data. All ASRS reports are voluntarily submitted, and thus cannot be considered a measured random sample of the full population of like events. For example, we receive several thousand altitude deviation reports each year. This number may comprise over half of all the altitude deviations which occur, or it may be just a small fraction of total occurrences. We have no way of knowing which.

Moreover, not all pilots, controllers, air carriers, or other participants in the aviation system, are equally aware of the ASRS or equally willing to report to us. Thus, the data reflect **reporting biases.** These biases, **which are not fully known** or measurable, distort ASRS statistics. A safety problem such as near midair collisions (NMACs) may appear to be more highly concentrated in area "A" than area "B" simply because the airmen who operate in area "A" are more supportive of the ASRS program and more inclined to report to us should an NMAC occur.

Only one thing can be known for sure from ASRS statistics--they represent the **lower measure** of the true number of such events which are occurring. For example, if ASRS receives 300 reports of track deviations in 1993 (this number is purely hypothetical), then it can be known with certainty that at least 300 such events have occurred in 1993.

Because of these statistical limitations, we believe that the **real power** of ASRS lies in the **report narratives.** Here pilots, controllers, and others, **tell us about aviation** safety incidents and situations in detail. They explain what happened, and more importantly, **why** it happened. Using report narratives effectively requires an extra measure of study, the knowledge derived is well worth the added effort.

APPENDIX D

SURVEY PARTICIPANTS AND

BY-LAWS OF THE UAA

Aims Community College
P. O. Box 69
Greeley,CO 80632
3033308008

Andrews University
Dept. Aviation
Berrien Springs,MI 49104
6164711455

Arizona State University
Dept. of Aeronautical Tech.
Tempe,AZ 85287
6029654033

Auburn University
211 Aerospace Engineering
Auburn University,AL 368495338
2058446848

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420 W. Main Street
Danville,VA 24540
8047915615

Baylor University
P. O Box 97413
Waco,TX 767987413
8177553563

Bridgewater State College
Maxwell Library, Park Avenue
Bridgewater,MA 02325
5086971779

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Pembroke Pines,FL 33024
3059638910

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TRG 210 Dept. of Power and Tran
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8175261241

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4049613569

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8007295101

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6023640302

College of Aeronautics
La Guardia Airport
Flushing,NY 11371
7184296600

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Beckley,WV 25802
8007666067

Community Col. of Beaver Co.
Avn. Science Ctr 125 Cessna Dr.
Beaver Falls,PA 150101060
4128477000

Concordia Univ. Wisconsin
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Mequon,WI 530972402
4142435700

Daniel Webster College
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Nashua,NH 03063
6035776611

Davis College
4747 Monroe Street
Toledo,OH 43623
4194732700

Delaware State College
1200 North DuPont Highway
Dover,DE 19901
3027393535

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6018464208

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School of Aviation & Trans.
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5162443320

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Richmond,KY 404753131
6066221014

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7196328116

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9046338289

Florida Institute of Tech.
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4077688000

Gateway Technical College
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Kenosha,WI 53144
4146566977

Guilford Tech. Comm. College
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Greensboro,NC 27410
9106659425

Hesston College
P. O. Box 3000
Hesston,KS 67062
3163278321

Indiana State University
Classroom Bldg, Room 103
Terre Haute,IN 47809
8122372641

Kansas State University-Salina
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Salina,KS 67401
9138262679

Louisiana Tech University
P. O. Box 3181, Tech Station
Ruston,LA 712729989
3182572691

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Trenton,NJ 08690
6095864800

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Murfreesboro,TN 37132
6158982788

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9038747849

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4046514323

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Airway Science Program
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8047275418

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8088479861

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Bayamon,PR 00959
8097241912

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Allentown,PA 18103
2152647085

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4079940770

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3035562982

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4042200159

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5044473386

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7057225129

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Ottumwa,IA 52501
5156835232

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Inver Grove Heights,MN 55075
6124508564

Lewis University
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Romeoville,IL 60441
8158380500

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Mankato,MN 560028400
5073895430
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11011 S.W. 104 Street
Miami,FL 331763393
3052372980

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2143338774

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Norfolk,VA 23504
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Monroe,LA 71209
3183421780

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2nd & I N.E., Box 3855
Miami,OK 74354
9185428441

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6901 Sudley Road
Manassas,VA 22110
7032576608

Northwest Technical College
1301 Highway One East
Thief River Falls,MN 567012599
2186815424

Ohio University
Ohio University Airport
Athens,OH 457012979
6146982028

Oklahoma State University
300 N. Cordell, OSU Aviation
Stillwater,OK 74074
4057445856

Palo Alto College
1400 W. Villaret Blvd.
San Antonio,TX 78224
2109215173

Parks College of St. Louis University
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6183377500

Pittsburgh Inst. of Aeronautics
P.O. Box 10897
Pittsburgh,PA 15236
4124629011

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Highway 61
Pratt,KS 67124
3166725641

Purdue University
Aviation Tech. Department
West Lafayette,IN 479063398
3174949950

Richard J. Daley College
7500 S. Pulaski Road
Chicago,IL 60652
3128380300

Rocky Mountain College
1511 Poly Drive
Billings,MT 59102
4066571060

Rogers State College
Advanced Aviation Technology
Claremore,OK 740172099
9183417510

Rose State College
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4057333778

San Jacinto College
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Pasadena,TX 77501
7134761501

San Jose State University
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4089246580

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6184538898

St. Cloud State University
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St. Cloud,MN 563014498
6122552107

St. Francis College
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7185222300

Tennessee State University
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Nashville,TN 37209
6153203287

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Houston,TX 77004
7136391847

Texas State Technical College
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Waco,TX 76705
8177993611

The Ohio State University
164 W. 19th Ave., Aviation Bldg.
Columbus,OH 432101110
6142925636

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9186317511

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7194722245

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Dubuque,IA 52001
3195893179

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4025543424

Univ. College of Fraser Valley
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6048544550

Univ. of Oklahoma
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Norman,OK 73069
4053251928

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8128854500

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2137403995

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Wallace State College
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2057394452

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1845 Fairmont
Wichita,KS 672600088
3166893367

Univ. of Nebraska-Kearney
Bus. Dept., West Campus, WCE2
Kearney,NE 68849
3082348570

Univ. of the Dist. of Columbia
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Washington,DC 20008
2022746205

Univ. of North Dakota
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Grand Forks,ND 582029007
7017772185

Utah Valley State College
800 W. 1200 South
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8012228000

Western Michigan Univ.
WMU Aviation Bldg.
Kalamazoo,MI 490083899
6163876587

Wilmington College
320 DuPont Highway
New Castle,DE 19720
3023249401

BY - LAWS

of the

UNIVERSITY AVIATION
ASSOCIATION

(Revised October 1990)

BY-LAWS

OF THE

UNIVERSITY AVIATION ASSOCIATION

(Revised October 1990).

ARTICLE I
ORGANIZATION

The University Aviation Association, Inc. (hereinafter referred to as the "Association"), is organized as a not-for-profit corporation, under the Illinois General Not-For-Profit Corporation Act, and the principal office and registered agent of the Association shall be located in the City of Chicago, State of Illinois, or such other location within the State of Illinois as the Association may designate.

ARTICLE II
PURPOSES OF ASSOCIATION

Section 2.1. The purpose of the association is the development and advancement of aviation education; and to promote, encourage, or foster any athletic, charitable, benevolent, or eleemosynary purpose or activity.

Section 2.2. The Association shall have such powers as are now or may hereafter be granted by the Illinois General Not-For-Profit Corporation Act.

Section 2.3. the Association shall not engage in any business of a kind ordinarily carried on for profit and nothing in these By-laws shall authorize the Association to, and the Association shall not enter into any transaction, carry on any activity, or engage in any business for pecuniary profit, and any monies received by the Association shall be applied exclusively for the not-for-profit purposes and objects of the Association as set forth herein, and no part thereof shall inure to the benefit of any private individual.

ARTICLE III
OBJECTIVES OF ASSOCIATION

Section 3.1. The objectives of the Association are: to encourage and promote the attainment of the highest standards in aviation education at the college level; to provide a means of developing a cadre of aviation experts who would be available for such activities as consultation, aviation program evaluation, speaking assignments, and other professional contributions that would tend to stimulate and develop aviation education in all of its phases; to furnish a national vehicle for the dissemination of intelligence relative to aviation between institutions of higher education and governmental and industrial organizations in the aerospace field; to permit the interchange of information between institutions that offer aviation programs that are non-engineering oriented; for example, business, technology, transportation, and education; to actively support aerospace-oriented teacher education with particular emphasis on workshops and the development of materials; to provide for the administration of the National Intercollegiate Flying Association Foundation through the appointment of Trustees of the NIFA Foundation as provided in the Foundation By-laws and letter of agreement to the President of the University Aviation Association: and to actively support the National Intercollegiate Flying Association and provide for the administration of the Association through the appointment of members of the NIFA Council as provided in By-laws of NIFA. The Council will have complete and final authority over all activities of NIFA as provided by the By-laws of NIFA.

Section 3.2. No part of the net earnings of the Association shall inure to the benefit of, or be distributed to, its members, trustees, officers, or other private persons, except that the Association shall be authorized and empowered to pay reasonable compensation for services rendered and to make payments and distributions in furtherance of the purposes set forth. No substantial part of the activities of the Association shall be the carrying on of propaganda, or otherwise attempting to influence legislation and the corporation shall not participate in, or intervene in (including the publishing or distribution of statements), any political campaign on behalf of any candidate for public office. Notwithstanding any other provision of these articles, the Association shall not carry on any other activities not permitted to be carried on [a] by an association exempt from Federal income tax or [b] by an association, contributions to which are deductible under Section 170 (c)(2) of the Internal Revenue Code of 1954.

ARTICLE IV
MEMBERSHIP

Section 4.1. Membership shall be approved by the Board of Trustees upon recommendation of any officer, member, or the Executive Director. Membership categories will be institutional, professional, associate, corporate, affiliate, and emeritus.

Section 4.2. Institutional membership will be open to professionally accredited, technical or associate and baccalaureate level institutions with an existing or planned aviation program or course offerings. Institutions will designate one individual as the voting representative.

Section 4.3. Professional membership shall be a voting membership open to all persons on college or university faculty or staff engaged in or interested in the furtherance of any forms of aviation education.

Section 4.4. Associate membership shall be a voting membership open to any person with a sincere interest in furthering aviation education. This includes, but is not limited to, persons employed directly or in a consultant status in the aerospace industry.

Section 4.5. Corporate membership will be open to organizations and enterprises which have an interest and concern in the purpose and goals of the Association. Organizations will designate one individual as the voting representative.

Section 4.6. Affiliate membership shall be a voting member open to undergraduate students in aviation programs. This membership category shall be closed when it reaches 20% of the Professional membership total.

Section 4.7. Honorary membership shall be a non-voting membership bestowed on those patrons of aviation education who have contributed to the advancement of the Association's aims.

Section 4.8. Emeritus membership shall be a non-voting membership granted to past professional and associate members who no longer are otherwise eligible.

Section 4.9. Acceptance of membership in the Association shall automatically constitute a pledge on the part of each member to uphold the By-laws of the Association and to abide by and adhere to all decisions made and courses of action taken by the Association pursuant to the By-laws.

ARTICLE V
PATRON

The Patron of University Aviation Association designation will be made to government or industry, company or organization with an interest in furthering aviation education which contributes $200 or more annually in dollars or equivalent services to UAA. Services which may be "in kind" will be in direct support of the ongoing activities and programs rather than grants or contracts for developmental type projects. Patrons may request earmarking or designation of funds contributed with the final decision on awarding patron or continuing patron on the basis of such stipulation left to the UAA Board of Trustees.

ARTICLE VI
OFFICERS

Section 6.1. The officers of this corporation shall be a president, a president-elect, a secretary and a treasurer.

Section 6.2. The officers of president and president-elect shall be limited to those members categorized as professional. All other officers and board membership may be held by any member categorized as professional or associate.

Section 6.3. All officers shall be elected by the voting members of the Association. A plurality of all votes cast shall be necessary to an election. The Board of Trustees shall have the power to prescribe the rules of the election. Each officer shall hold office for the term of one year.

Section 6.4. The president shall preside at annual meetings and other appropriately scheduled meetings, shall appoint chairman for working committees, shall initiate and carry out appropriate administrative tasks as decided by the membership, shall coordinate the activities and functions of the officers with those of the office of the executive director in order to ensure efficient progress towards Association objectives. The president shall sign all written contracts and obligations duly authorized by the Board of Trustees with the exception of checks, and shall counter sign all written contracts and other legal obligations as initiated by the office of Executive Director and authorized by the Board of Trustees. In the event of resignation, inability to serve, or death of the President, the order of succession to the presidency shall be the president-elect to the most recent available past president.

Section 6.5. The president-elect shall assist the president in the performance of duty, preside in the absence of the president, and coordinate with the office of executive director as transition is made from president-elect to president.

Section 6.6. The secretary shall be responsible for recording the minutes of the annual meeting and all other official meetings of the Association which will be distributed to members for approval. The secretary shall maintain the official minutes and records of the Association and shall provide to any trustee, officer or member of the Association any pertinent information as it relates to the official activities of the Association.

Section 6.7. The treasurer shall be responsible for the control of all monies taken in and disbursed by the Association and shall provide a report of the Association's financial condition at the annual meeting and at other meetings upon request by the Board of Trustees. The treasurer will be authorized to sign all checks for disbursement on behalf of the Association and may delegate authority for signing of checks to the executive director for those monies budgeted to the office of executive director in accordance with the approved budget. The treasurer shall have the authority to appoint an assistant treasurer. The assistant treasurer shall have the authority to perform all duties of the treasurer as set forth in the By-laws. The assistant treasurer shall not be considered a member of the Board of Trustees. Checks may be signed for the Association by the president in the absence of the treasurer. The treasurer will be responsible for the overall financial condition of the Association and will prepare, with input from the officers and the executive director, the annual budget for approval by the Board of Trustees. The treasurer will make appropriate recommendations to the Board of Trustees concerning all grants and donations solicited by and/or offered to the Association.

ARTICLE VII
TRUSTEES

Section 7.1. A Board of Trustees shall consist of these officers, together with nine trustees selected from the active membership and the immediate past president, if not otherwise a member of the board. The trustees shall be elected in groups of three for a three year term to provide board geographic representation of the Association membership if at all possible.

Vacancies that may occur on the Board of Trustees shall be filled by appointment by the president for the unexpired term of the member vacating the position.

Section 7.2. The Board of Trustees shall be responsible for the business of the Association, shall make and enforce necessary rules for its management, and shall present at each annual meeting a complete statement of the financial condition of the Association, including its receipts and expenditures, and its assets and liabilities. It shall be empowered to authorize any trustee to act for the secretary in his absence, it will draft all amendments to the By-laws for approval by the membership, and it will oversee the office of executive director including the appointment of the executive director to office.

Section 7.3. A majority of the Board of Trustees shall constitute a quorum for the transaction of business. All actions of the Board of Trustees under the authority of this article shall be reported to the Association at the first meeting succeeding their adoption by the board.

ARTICLE VIII
PROFESSIONAL STAFF

Section 8.1. The Association may have an executive director who shall direct the work of the Association in accordance with the policies and procedures as established by the Board of Trustees. The executive director shall be appointed by the Board of Trustees and shall be directly responsible to the board. The executive director shall be an ex officio member of all standing and special committees of the Association. If the position of executive director becomes vacant, the Board of Trustees shall appoint an acting director to serve until a new executive director is appointed.

Section 8.2. The executive director may, in accordance with the Association budget, provide for such other staff personnel necessary to carry out the purposes of the Association. Such personnel as identified by position in approved budget shall be selected and hired by the executive director.

ARTICLE IX
MEETINGS

Section 9.1. There shall be at least one annual meeting of this Association at such time and place that the Board of Trustees elect.

Section 9.2. Special meetings may be held upon the call of the Board of Trustees or upon petition of ten members. A written notice of such special meetings must be received by each member at least one week before the date appointed. This notice shall state the reason for the calling of the meeting and no business shall be transacted thereat except that specifically referred to in the notice.

Section 9.3. At any meeting of the Association, twenty members shall constitute a quorum, but a smaller number may adjourn to a later date.

ARTICLE X
COMMITTEES

The Board of Trustees, or the president, upon authorization of the Board of Trustees, may appoint such special committees as they may deem advisable.

ARTICLE XI
FISCAL YEAR

The annual business year of the Association shall be from October 1 to the following September 30 and designated as the fiscal year of the initial month.

ARTICLE XII
DUES

Section 12.1. Dues for all membership categories will be established at the annual meeting for the subsequent year.

Section 12.2. Dues for all memberships shall be due on the anniversary dates of initial membership and delinquent two months thereafter.

ARTICLE XIII
AMENDMENTS

These By-laws may be amended by proposed action of the Board of Trustees on their own initiative or upon petition from five active members, and subsequent proposed action by the Board of Trustees. In either case, the proposed action shall be subsequently reported to the membership for final approval or disapproval.

ARTICLE XIV
WAIVER OF NOTICE

Whenever any notice whatsoever is required to be given under the provisions of the Illinois Not-For-Profit Corporation Act or under the provisions of the Articles of Incorporation or the By-laws of the Association, a waiver thereof in writing signed by the person or persons entitled to such notice, whether before or after the time stated therein, shall be deemed equivalent to the giving of such notice.

ARTICLE XV
RULES OF ORDER

Roberts Rules of Order, latest edition, is the authority governing proceedings in meetings and conferences of the Association, board, and officers, so far as such rules are not in conflict with the By-laws.

ARTICLE XVI
DISSOLUTION

Upon the dissolution of the Association, the Board of Trustees shall, after paying or making provision for the payment of all of the liabilities of the Association, dispose of all the assets of the Association exclusively for the purpose of the corporation in such manner, or to such organization organized and operated exclusively for charitable, educational, religious, or scientific purposes as shall at the time qualify as an exempt organization or organizations as the Board of Trustee shall determine. Any such assets not so disposed of shall be disposed of by the Court of Common Pleas of the county in which the principal office of the Association is then located, exclusively for such purposes or to such organization or organizations, as said Court shall determine, which are organized and operated exclusively for such purposes.

APPENDIX E

MILITARY PHYSIOLOGICAL TRAINING
FACILITIES

Aerospace Physiological Training Unit
1299th PTF
Andrews AFB, MD 203315300
3019814654
3019812469

Aerospace Physiological Training Unit
14 Med Sq/SGT
Columbus AFB, MS 397015300
6014342781
6104342889

Aerospace Physiological Training Unit
Avtn Phys Trng Dpt
NAS Barbers Point, HI 968625300
8086844149
8086840354

Aerospace Physiological Training Unit
47 Med Sq/SGT
Laughlin AFB, TX 788435244
2102985761
2102986489

Aerospace Physiological Training Unit
21 Med Gp/SGT
Peterson AFB, CO 809141530
7195564185
7195567960

Aerospace Physiological Training Unit
363 Med Gp/MGT
Shaw AFB, SC 291525300
8039643838
8039642614

Aerospace Physiological Training Unit
325 Med Grp/MGT
Tyndall AFB, FL 324035300
9045232947
9045232536

Aerospace Physiological Training Unit
9 Med Gp/SGT
Beale AFB, CA 959031215
9166348347
9166348319

Aerospace Physiological Training Unit
650 Med Gp/SGT
Edwards AFB, CA 935246175
8052774535
8052773916

Aerospace Physiological Training Unit
49 Med Gp/MGT
Holloman AFB, NM 883308273
5054755771
5054757775

Aerospace Physiological Training Unit
314 Med Gp/SGT
Little Rock AFB, AR 720997204
5019887389
5019887350

Aerospace Physiological Training Unit
12 Med Sp/SGT
Randolph AFB, TX 781504801
2106524931
2106520544

Aerospace Physiological Training Unit
82 Med Gp/SGT
Sheppard AFB, TX 763112139
8176762777
8176766416

Aerospace Physiological Training Unit
71 Med Sq/SGT
Vance AFB, OK 737055105
4052497252
4052497342

Aerospace Physiological Training Unit
USAFSAM/FP
Brooks AFB, TX 782355123
2105363365
2105362335

Aerospace Physiological Training Unit
92 Med Gp/SGT
Fairchild AFB, WA 990115406
5096575406
5096575045

Aerospace Physiological Training Unit
1 Med Gp/MGPT
Langley AFB, VA 236652080
8047647827
8047647828

Aerospace Physiological Training Unit
55 Med Gp/SGT
Offutt AFB, NE 681132160
4022944400
4022942816

Aerospace Physiological Training Unit
64 Med Sq/SGT
Reese AFB, TX 794895008
8068855008
8068856361

Aerospace Physiological Training Unit
60 Med Gp/SGPH
Travis AFB, CA 945351800
7074233987
7074237416

Aerospace Physiological Training Unit
645 Med Gp/SGT
Wright-Patt AFB, OH 454337007
5132554566
5132555253

APPENDIX F

SURVEY AND COVER LETTER

Dear

I am a doctoral student at Oklahoma State University in the Department of Aviation and Space Education. I am currently undertaking a dissertation study concerning general aviation pilots. Of special interest is education facilities that offer aviation related courses as part of their curricula.

A review of NTSB accident reports from 1990 through 1993 appear to indicate that several accidents have been caused by factors related to aeromedical issues. The FAA requires training in aeromedical factors for all pilots but does not specifically recommend a course of study to facilitate learning about these potential problems. This study was designed to ascertain the current level of instruction. as well as to develop a unified course of instruction in aeromedical factors. I am soliciting both your opinions and your cooperation to help me complete a study concerning general aviation education. I would be most grateful for your participation in my survey

The data provided by you and other institutions that offer aviation-related courses will be analyzed. Once gathered and analyzed a copy will be sent to the University Aviation Association and copies will be available to all participants. These data should provide an excellent cross-section of the educational community's feelings on physiological training for student pilots. As an aviation administrator, your input will be invaluable.

Please do not hesitate to call or write if you have any questions or comments. Thank you for your advice and assistance in this endeavor.

Sincerely,

David M. Conway
300 North Cordell
Stillwater, OK 74078-0442

(405)-744-7296

Kenneth E. Wiggins
Professor and Head

Oklahoma State University
Aeromedical Factors in General Aviation: A Study of College and University Curricula Requirements and Recommendations.

Please take a few moments to complete the following survey items:

1. Does your aviation education program require instruction in aeromedical factors? Yes____ No____ (If no, go to # 5)
   If yes, how do you provide aeromedical factors instruction? ____ Home Study ____ Ground School ____ College course

2. Does your program provide formal course training in aeromedical factors? Yes ___ No ___
   If yes, at what level(s)? _____ Freshman _____ Sophomore_____ Junior_____ Senior
   _____ Other (please describe)________________________

   If yes, please check the subjects taught in your aeromedical factors class:

___ Hypoxia	___ Hyperventilation	___ Spatial Disorientation
___ Vibration	___ Motion sickness	___ Fatigue
___ Drugs and Alcohol	___ Noise	___ Oxygen equipment
___ Stress	___ Earth's atmosphere	___ Gas Laws
___ Illusions in flight	___ Acceleration (G forces)	___ Circulation
___ Respiration	___ Effects of pressure changes	___ Vision in flight
___ Decompression sickness	___ Cabin pressurization & decompression	___ Other ____________

   If yes, do you give semester credit hours for aeromedical factors instruction? Yes____ No____
   If yes, how many semester credit hours are awarded? ________hours

   If yes, what is the length of the course? contact hours ____ or course hours ____ or ____ semester credit hours

   If yes, who teaches aeromedical factors? _____ Certified Flight Instructor _____ Adjunct Faculty_____ Faculty
   _____ Other (please specify) ________________

   If yes, is the instructor in aeromedical factors specially trained, i.e. a physiologist? Yes____ No____

   If yes, do you use a textbook for aeromedical factors instructions? Yes____ No____
   If yes, please list in the space below, or on a separate page, all related texts and material used.

3. Does your training program incorporate the use of aeromedical training equipment? _____ Yes _____No
   If yes, check all that apply: _____ Spatial disorientation trainer_____ Altitude chamber_____ Night vision trainer
   _____ Barany chair_____ Oxygen laboratory_____ Other (please specify) __________

4. Does your program ___ encourage, ___ require, or ___ not require students to attend an FAA, military, or other physiological training facility for a course in aeromedical factors?

5. What is the distance from your training program to the nearest FAA or military physiological training facility? _______ miles

6. Do you personally feel **formal instruction** on aeromedical factors are (**circle the appropriate numbered response**):

unnecessary — necessary — absolutely necessary

1 2 3 4 5 6 7 8 9 10

(OVER)

For questions 7 - 11 assume you have unlimited resources

7. From the list below **rank order** the topics you would include in an aeromedical factors course:

___ Hypoxia	___ Hyperventilation	___ Spatial Disorientation
___ Vibration	___ Motion sickness	___ Fatigue
___ Drugs and Alcohol	___ Noise	___ Oxygen equipment
___ Stress	___ Earth's atmosphere	___ Gas Laws
___ Illusions in flight	___ Acceleration (G forces)	___ Circulation
___ Respiration	___ Effects of pressure changes	___ Vision in flight
___ Decompression sickness	___ Cabin pressurization & decompression	___ Other (please list and rank below)

8. Would you include training in an altitude chamber? Yes____ No____
   If yes, what maximum altitude would you deem appropriate:
   ___ 10,000 feet___ 15,000 feet___ 20,000 feet___ 25,000 feet___ 30,000 feet___ 35,000 feet___ Other (please specify)

9. What do you feel is the optimum undergraduate or graduate level to educate aviation students in aeromedical factors?
   ____ Freshman_____ Sophomore_____ Junior_____ Senior_____ Other (please describe)________________________

10. Whom do you feel would be the best person to provide instruction in aeromedical factors? (**please rank order**)
   _____ Certified Flight Instructor_____ Adjunct Faculty_____ Faculty_____ Other (please specify) ________________

   What educational qualifications would you desire in a aeromedical factors training instructor? (**please rank the top three**)

_____ Doctor of Medicine (M.D.)	_____ Certified Flight Instructor (CFI)
_____ Doctor of Osteopathy (D.O.)	_____ Doctor of Philosophy (Ph.D)
_____ Doctor of Education (Ed.D)	_____ Basic/Advanced Ground Instructor (BGI/AGI)
_____ Military trained Physiologist	_____ Other (please specify)

11. Describe in the space below what you consider to be an optimum aeromedical training program for college and university aviation students and any comments you have concerning this subject (attach additional pages if necessary).

Return to: David M Conway, 300 North Cordell, Stillwater, OK 74074-0042 (405) 744-7296

APPENDIX G

INSTITUTIONAL REVIEW BOARD
APPROVAL FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 09-12-94 **IRB#:** ED-95-012

Proposal Title: AVIATION PHYSIOLOGY IN GENERAL AVIATION: A STUDY OF COLLEGE AND UNIVERSITY CURRICULA REQUIREMENTS AND RECOMMENDATIONS

Principal Investigator(s): Loren G. Martin, David M. Conway

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

APPROVAL STATUS SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING.
APPROVAL STATUS PERIOD VALID FOR ONE CALENDAR YEAR AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Reasons for Deferral or Disapproval are as follows:

Signature: [signature] Date: September 15, 1994
Chair of Institutional Review Board

VITA

David M. Conway

Candidate for the Degree of

Doctor of Education

Thesis: AVIATION PHYSIOLOGY IN GENERAL AVIATION: A STUDY OF COLLEGE AND UNIVERSITY CURRICULA REQUIREMENTS AND RECOMMENDATIONS

Major Field: Higher Education

Biographical:

Personal Data: Born in York, Nebraska, November 25, 1951, the son of John and Shirley Conway. Married Cathy Ward from Commerce, Texas in1972; one son, Christopher, born in 1983.

Education: Graduated from Commerce High School, Commerce, Texas in May 1970; received Bachelor of Science Degree in Biology degree from East Texas State University, Commerce, Texas in May 1974; received Master of Systems Management Degree from University of Southern California, Los Angeles, California in May 1981; completed the requirements for the Doctor of Education Degree at Oklahoma State University, Stillwater, Oklahoma in July 1995.

Professional Experience: United States Air Force Officer, 1974-1994. United States Air Force Pilot, Barksdale Air Force Base, Bossier City, Louisiana, 1975-1981; United States Air Force Instructor Pilot, Sheppard Air Force Base, Wichita Falls, Texas, 1981-1985; Flight Training Wing Section Commander and Flight Commander, Sheppard Air Force Base, Whicita Falls, Texas, 1981-1985; Instructor, Evaluator, Training Flight, Flight Commander, and Functional Check Flight Pilot, K.I. Sawyer Air Force Base, Guinn, Michigan, 1985-1988; Scheduling and Training Division Chief, 17th Air Force, Sembach Air Base, Germany, 1988-1991. Aerospace Physiology Training Unit Commander, Vance Air Force Base, Enid Oklahoma, 1991-1994.

Professional Memberships: Phi Delta Kappa, American Physiological Society, Aerospace Medical Association, Pinnacle.