ORDER

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

1110.130

SUBJ: AVIATION PHYSIOLOGY EDUCATION RULEMAKING ADVISORY COMMITTEE

1. PURPOSE. This order constitutes the charter for the Aviation Physiology Education Rulemaking Advisory Committee that is designated and established pursuant to the Administrator's authority under 49 U.S.C. Section 106(p)(5).

2. DISTRIBUTION. This order is distributed at the director level throughout the Office of the Associate Administrator for Regulation and Certification in Washington headquarters.

3. BACKGROUND. On December 20, 2000, the National Transportation Safety Board (NTSB) issued safety recommendations as a result of its investigation of the October 25, 1999, crash of a Learjet Model 35 airplane near Aberdeen, South Dakota. The NTSB determined that the probable cause of this accident was "incapacitation of the flight crewmembers as a result of their failure to receive supplemental oxygen following a loss of cabin pressurization, for undetermined reasons." Recommendation A-00-110 recommends that the FAA "convene a multidisciplinary panel of aeromedical and operational specialists to study and submit a report on whether mandatory hypoxia awareness training, such as altitude chamber training, for civilian pilots would benefit safety. The report should consider alternatives to altitude chamber training, clearly identify which pilots and/or flight operations would benefit most from such training, and determine the scope and periodicity of this training. If warranted, establish training requirements based on the findings of this panel."

4. OBJECTIVES AND SCOPE. The general objectives and scope of the task force's work are preliminarily defined in this paragraph. Definitive tasking statements and assignments for the committee will be provided by the Associate Administrator for Regulation and Certification. The committee's primary task is to study and submit a report on aviation physiological education. This study should consider whether mandatory hypoxia awareness training, including altitude chamber training, would benefit safety. The study should further identify which pilots and/or flight operations would benefit from training, consider the scope and periodicity of training, and consider alternatives to altitude chamber training. The committee will make its recommendations to the FAA, including any recommendations for rulemaking, as appropriate.

5. PROCEDURES.

a. The committee provides advice and recommendations on the safety benefit of mandatory hypoxia awareness to the Associate Administrator. The committee acts solely in an advisory capacity.

b. The committee shall first meet with such employees of the FAA as may be designated by the Associate Administrator for Regulation and Certification, and present whatever input, guidance and recommendations the members of the committee consider relevant to the ultimate disposition of this issue.

c. On a date specified by the Associate Administrator for Regulation and Certification, the committee shall present the Associate Administrator with its final written recommendations in the form of a report, including any recommendations for rulemaking.

6. ORGANIZATION AND ADMINISTRATION.

a. The Associate Administrator for Regulation and Certification shall have the sole discretion to appoint members to the committee. The committee shall consist of employees of the FAA and members of the public representative of the various viewpoints of the medical and aviation communities.

b. The Associate Administrator for Regulation and Certification shall receive all committee recommendations and reports. The Associate Administrator, through the Flight Standards Service, shall also be responsible for providing administrative support for the committee. Flight Standards Service will provide the designated Federal official for this committee. The designated Federal official will attend all meetings of the committee.

c. The Associate Administrator for Regulation and Certification is the sponsor of the committee and shall designate the Chair of the committee from the membership of the committee. Once designated, the Chair:

(1) Determines, in coordination with the other members of the committee, when a meeting is required and where it will be held.

(2) Arranges notification to all committee members of the time and place for any meeting.

(3) Formulates an agenda for each meeting and conducts the meeting.

d. Minutes of committee meetings will be kept.

e. The committee's meetings will be open to the public.

7. MEMBERSHIP.

a. The committee consists of member organizations selected by the FAA based on a balanced representation of interests and knowledge of the subject matter.

b. The members of the committee shall include representatives of the following Federal agencies and aviation organizations:

(1) Federal Aviation Administration

(2) Department of the Air Force

(3) Air Transport Association of America

(4) Air Line Pilots Association International

(5) Aerospace Medical Association

(6) National Air Transportation Association

(7) National Business Aircraft Association

(8) National Air Carrier Association

(9) Experimental Aircraft Association

(10) Regional Airline Association

(11) General Aviation Manufacturers Association

(12) Delta Air Lines

(13) Bombadier Aerospace

(14) University of North Dakota

(15) Aircraft Owners and Pilots Association

8. COMPENSATION. Non-Government representatives serve without Government compensation and bear all costs related to their participation on the committee.

9. COSTS. The estimated annual operating cost (including pro rata share of salaries of FAA employees) is $25,000.

10. PUBLIC PARTICIPATION. Interested persons wishing to attend a meeting who are not members of the committee must request and receive approval in advance of the meeting from the Associate Administrator.

11. AVAILABILITY OF RECORDS. Subject to the conditions of the Freedom of Information Act, 5 U.S.C. Section 522, records, reports, agendas, working papers, and other documents that are made available to or prepared for or by the committee shall be available for public inspection and copying at the FAA Flight Standards Service, 800 Independence Avenue, SW., Washington, D.C. 20591. Fees shall be charged for information furnished to the public in accordance with the fee schedule published in

part 7 of title 49, Code of Federal Regulations.

12. PUBLIC INTEREST. The formation of the Aviation Physiology Education Aviation Rulemaking Advisory Committee is determined to be in the public interest in connection with the performance of duties imposed on FAA by law.

13. EFFECTIVE DATE AND DURATION. This committee is effective July 12, 2001. The committee shall remain in existence until July 1, 2003, unless sooner terminated or extended by the Administrator.

Jane F. Garvey
Administrator

AVIATION PHYSIOLOGY EDUCATION RULEMAKING ADVISORY COMMITTEE

FINAL REPORT

SEPTEMBER 2002

Executive Summary

On October 25, 1999, a Learjet Model 35, registration number N47BA, crashed near Aberdeen, South Dakota. It was operated by Sun Jet Aviation of Sanford, Florida. The National Transportation Safety Board determined that the probable cause of this accident was incapacitation of the flight crewmembers as a result of their failure to receive supplemental oxygen following a loss of cabin pressurization. Reasons for the loss of cabin pressurization were undetermined.

In July 2001, Administrator Garvey signed Order 1110.130 establishing the Aviation Physiology Education Rulemaking Advisory Committee (the Committee). The Committee's primary task was to study the issues surrounding the accident and to submit a report on aviation physiological education. This study was to consider whether mandatory hypoxia awareness training, including altitude chamber training, would benefit safety.

The Committee held three meetings: July 12, 2001; December 4, 2001; and March 19, 2002. Representatives of the FAA, pilot and aviation industry organizations, and the public considered accident reports, medical issues, training, and industry practice. They considered pilot opinions expressed in surveys and current regulations and test standards. The Committee discussed possible changes to the current regulations, by the type of pilot certificate held, to the type of operations performed. The Committee discussed different altitudes, and the possible hypoxia effects at the various altitudes. Finally, they discussed human factors involved in hypoxia issues, such as the fact that some highly trained pilots may ignore the signs of cabin de-pressurization .

The most contentious issue was the 25,000 ft. mean sea level (MSL) triggering altitude of the current regulations: Part 61 requires that all pilots operating pressurized aircraft capable of operating above 25, 000 ft. (MSL) must receive hypoxia training. The Committee recognized that hypoxia can occur at altitudes lower than 25,000 ft. In addition, the Part 91 requirement for supplemental oxygen at 12,500 ft. MSL creates a somewhat contradictory situation in the regulations.

In the final analysis, the Committee did not find any compelling reasons data that would justify a regulatory change. The lack of compelling accident data over a 20 year period coupled with the availability of specialized training supplemented by videos, on-line courses, presentations by pilot and aviation industry organizations and programs promoted by the FAA led the Committee to conclude that regulatory change is not warranted nor recommended. The Committee also recommends that the FAA as well as pilot and aviation industry organizations review and update current available sources of training. The committee discovered that some of the available reference material are out-of-date and are not consistent with the current training. Working agreements between the FAA and the various pilot and aviation industry organizations could also make training and reference materials available to pilots for little or no cost. Such an effort would require additional funding for production and distribution costs.

1. Background

On October 25, 1999, a Learjet Model 35, registration number N47BA, crashed near Aberdeen, South Dakota. It was operated by Sun Jet Aviation of Sanford, Florida. It was built in 1976, and had a serial number of 60. The Learjet model 35 is a twin turbo-fan executive jet. Crewed by two pilots, it can carry up to eight passengers.

On the morning of the accident, the aircraft was flown from Sanford to Orlando, Florida, where it picked up passengers. It departed around 9:19 a.m. with two pilots and four passengers destined for Love Field in Dallas, Texas. The planned flying time was 2 hours.

Air traffic control lost radio contact with the flight at 9:44 a.m. eastern daylight time, when the airplane was climbing through 37,000 feet mean sea level (MSL), northwest of Gainesville, Florida. The flight had been cleared to 39,000 feet MSL, and the aircraft was proceeding on a northwest heading.

The aircraft was intercepted at about 45,000 feet MSL by military aircraft, which followed the plane until it crashed near Aberdeen. Preliminary reports from the FAA place the crash time at 1:26 p.m. (eastern daylight time). The military pilots, who were in a position to observe the aircraft at close range, stated that the forward windshields seemed to be frosted or covered with condensation. They could not, however, see into the cabin of the aircraft. They observed no structural anomaly or other unusual condition.

The National Transportation Safety Board determined that the probable cause of this accident was incapacitation of the flight crewmembers as a result of their failure to receive supplemental oxygen following a loss of cabin pressurization. Reasons for the loss of cabin pressurization were undetermined.

In July 2001, Administrator Garvey signed Order 1110.130 establishing the Aviation Physiology Education Rulemaking Advisory Committee. The Committee's primary task was to study and submit a report on aviation physiological education. This study was to consider whether mandatory hypoxia awareness training, including altitude chamber training, would benefit safety.

2. Government Response

Following its final report, the NTSB forwarded several recommendations to the FAA. One of these is the subject of this final report:

Convene a multidisciplinary panel of aeromedical and operational specialists to study and submit a report on whether mandatory hypoxia awareness training, such as altitude chamber training, for civilian pilots would benefit safety. The report should consider alternatives to altitude chamber training, clearly identify which pilots and/or flight operations would benefit most from such training, and determine the scope and periodicity of this training. If warranted, establish training requirements based on the findings of this panel.

In July 2001, Administrator Garvey signed Order 1110.130 establishing the Aviation Physiology Education Rulemaking Advisory Committee. The Committee's primary task was to study and submit a report on aviation physiological education. This study was to consider whether mandatory hypoxia awareness training, including altitude chamber training, would benefit safety. The study was to further identify which pilots and/or flight operations would benefit from training, consider the scope and periodicity of training, and consider alternatives to altitude chamber training. The Committee was to make its recommendations to the FAA, including any recommendations for rulemaking, as appropriate.

The Associate Administrator for Regulation and Certification was designated sponsor of the Committee and given the authority to appoint members. The following industry organizations and government entities were represented: the FAA, Department of Air Force, Air Transport Association of America, Air Line Pilots Association, Aerospace Medical Association, National Air Transportation Association, National Business Aviation Association, National Air Carrier Association, Regional Airline Association General Aviation Manufacturers Association, Delta Air Lines, Bombadier Aerospace, University of North Dakota, Aircraft Owners and Pilots Association (AOPA).

At its first meeting on July 12, 2001, the Committee elected Kathy Hakala Perfetti, FAA, chairperson. A second meeting of the Committee was held on December 4, 2001, and a third meeting on March 19, 2002. Records of those meeting can be found at Tab A.

3. Current Regulations, Test Requirements, Practices

3.1 Title 14 of the Code of Federal Regulations Part 61.

The current regulatory requirements for training on high-altitude physiological aspects of flight are found in Section 61.31(g).

Section 61.31. Type rating requirements, additional training, and authorization requirements.

* * * * *

(g) *Additional training required for operating pressurized aircraft capable of operating at high altitudes.*

(1) Except as provided in paragraph (g)(3) of this section, no person may act as pilot in command of a pressurized aircraft (an aircraft that has a service ceiling or maximum operating altitude, whichever is lower, above 25,000 feet MSL), unless that person has received and logged ground training from an authorized instructor and obtained an endorsement in the person's logbook or training record from an authorized instructor who certifies the person has satisfactorily accomplished the ground training. The ground training must include at least the following subjects:
   (i) High altitude aerodymanics and meteorology;
   (ii) Respiration;
   (iii) Effects, symptoms, and causes of hypoxia and any other high-altitude sickness;
   (iv) Duration of consciousness without supplemental oxygen;
   (v) Effects of prolonged usage of supplemental oxygen;
   (vi) Causes and effects of gas expansion and gas bubble formation;
   (vii) Preventive measures for eliminating gas expansion, gas bubble formation, and high-altitude sickness;
   (viii) Physical phenomena and incidents of decompression; and
   (ix) Any other physiological aspects of high-altitude flight.

(2) Except as provided in paragraph (g)(3) of this section, no person may act as pilot in command of a pressurized aircraft unless that person has received and logged training from an authorized instructor in a pressurized aircraft, or in a flight simulator or flight training device that is representative of a pressurized aircraft, and obtained an endorsement in the person's logbook or training record from an authorized instructor who found the person proficient in the operation of a pressurized aircraft. The flight training must include at least the following subjects:
   (i) Normal cruise flight operations while operating above 25,000 feet MSL;
   (ii) Proper emergency procedures for simulated raid decompression without actually depressurizing the aircraft; and
   (iii) Emergency descent procedures.

(3) The training and endorsement required by paragraphs (g)(1) and (g)(2) of this section are not required if that person can document satisfactory accomplishment of any of

the following in a pressurized aircraft, or in a flight simulator or flight training device that is representative of a pressurized aircraft:

(i) Serving as a pilot in command before April 15, 1991;

(ii) Completing a pilot proficiency check for a pilot certificate or rating before April 15, 1991;

(iii) Completing an official pilot in command check conducted by the military services of the United States; or

(iv) Completing a pilot in command proficiency check under part 121, 125, or 135 of this chapter conducted by the Administrator or by an approved pilot check airman.

In addition to section 61.31(g), sections 61.35, 61.39, and 61.43 also address the required knowledge (written) and practical test (oral and written) tests.

Section 61.35 Knowledge Test: Prerequisites and Passing Grades

(a) An applicant for a knowledge test must have:

(1) ...accomplished the appropriate ground-training or a home-study course required by this part for the certificate and rating sought...

(b) The Administrator shall specify the minimum passing grade for the knowledge test.

Section 61.39 Prerequisites for Practical Test

(a) ...an applicant must:

* * * * *

(a)(6)(iii) ...demonstrated satisfactory knowledge of the subjects areas in which the applicant was deficient on the airman knowledge test;

Examples taken from the most recent FAA Knowledge (written) Tests:

703. J31 PVT (Private Pilot)
Which statement best defines hypoxia?
A. A state of oxygen deficiency in the body.
B. A condition of gas bubble formation around the joints or muscles.
C. An abnormal increase in the volume of air breathed.

688. J31 COM (Commercial Pilot)
Hypoxia is the result of which of these conditions?
A. Excessive carbon dioxide in the bloodstream.

B. Excessive oxygen in the bloodstream.
C. Insufficient oxygen reaching the brain.

96. E08 ATP (Airline Transport Pilot)
The certificate holder must give instruction on such subjects as respiration, hypoxia, gas expansion, and decompression to crewmembers who serve in operations above
A. FL 180.
B. FL 200.
C. FL 250.

533. J31 CFI (Certificated Flight Instructor)
Hypoxia is the result of
A. decreasing amount of oxygen as your altitude increases.
B. reduced barometric pressures at altitude.
C. excessive nitrogen in the bloodstream.

Section 61.43 Practical tests: General procedures.

* * * * *
(a)(3) Demonstrate satisfactory proficiency and competency within the approved standards.

Example from the Practical Test Standards – FAA-S-8081-14 (Private Pilot):

* * * * *
H. TASK: AEROMEDICAL FACTORS

Objective: To determine that the applicant exhibits knowledge of the elements related to aeromedical factors by explaining –

1. The symptoms, causes, effects, and corrective actions of at least three of the following –
   a. hypoxia
   b. hyperventilation
   c. middle ear and sinus problems
   d. spatial disorientation
   e. motion sickness
   f. carbon monoxide poisoning
   g. stress and fatigue

Section 61.97 (Recreational Pilot); Section 61.105 (Private Pilot); 61.125 (Commercial Pilot); 61.155 (Air Transport Pilot); 61.185 (Flight Instructor) –

Aeronautical knowledge.

These sections of the regulations refer to a demonstration of the knowledge applicable to the various pilot certificates as well as tie back to the knowledge (written) test and practical (oral and flight) test standards required by sections 61.96, 61.102, 61.123, 61.153, and 61.183.

Overview of Practical Test Standards:

- Recreational pilot, private pilot, and commercial pilot practical test standards require that the applicant exhibit knowledge of aeromedical factors. A recreational pilot applicant must explain 6 of 6 items; a private pilot must explain at least 3 of 7; a commercial pilot must explain 4 of 7; and a flight instructor applicant must explain 8 of 8. Airline transport pilot practical test standards does not make reference to aeronautical factors.

- Though the pilot examiner might not test a private or commercial pilot applicant on the cause and effects of hypoxia, the applicant must still be prepared to exhibit appropriate knowledge on all of the aeromedical factors referenced in the practical test standards including hypoxia.

- Reference to aeromedical factors are outdated or no longer available. The *Airplane Flying Handbook* (FAA-H-8083-3) has no reference to aeromedical factors. Reference is made to aeromedical factors in AC 61-21A, however, including hypoxia.

A handout presented to the Committee by the AOPA with more details on the *Handbook* and PTS is found at Tab B.

4. Medical Issues

4.1 **Overview**

Two significant physiological stresses that can be experienced by aviators in flight are hypoxia and decompression illness. Hypoxia is defined as a deficiency of oxygen at the tissue level. Oxygen comprises 21% of the barometric pressure at all altitudes even at the highest reaches of the atmosphere. With rising altitude there is a falling of barometric pressure. Hence, ambient oxygen pressure will decrease with less oxygen available to the body.

The level of toleration of hypoxia is related to other physiological factors; that is age, cardiopulmonary condition, illness, and self-imposed stress through smoking, alcohol, etc., will play a role in determining the reaction of a body to hypoxia.

The effects of hypoxia can be categorized into four stages according to altitude: At the indifferent stage [sea level – 10,000 ft. mean sea level (MSL)], pilots will experience increased heart rate, decrease in night vision, and performance decrement in performing novel tasks. At the compensatory stage (10,000-15,000 ft. MSL), drowsiness, slowing of reaction time, and slowing of mental processes can be expected. At the disturbance stage (15,000-20,000 ft. MSL), overt symptoms of hypoxia cannot be overcome by compensatory mechanisms; performance decrement endangers flight. Finally, in the critical stage (over 20,000 ft. MSL), the central nervous system and cardiovascular system are severely compromised with eventual incapacitation and possible death. The danger of hypoxia is its insidiousness because an airman may not recognize the symptoms.

Decompression in the cockpit may be very rapid (seconds) or prolonged (minutes). The effective performance time (EPT) is the time available to the pilot to effectively accomplish cockpit tasks after the decompression occurs. In slow decompression, the pilot may not be aware that he is becoming more and more hypoxic. In contrast, rapid decompression, with a loud noise or sudden appearance of fog, it may be more recognizable. The time that the pilot has to react to a decompression, however, varies dramatically. For example, the EPT at 18,000 ft. MSL is 20-30 minutes, but at 40,000 ft. MSL it is only 12-20 seconds.

Countermeasures for preventing hypoxia include supplemental oxygen, pressure suits, and a pressurized cabin. Today's cabin pressurization systems allow for cabin altitudes to remain at 8,000 ft. MSL or below, regardless of the aircraft's actual altitude. Training is paramount in recognizing hypoxia symptoms. The spectrum of training runs from a 30- minute introduction to hypoxia in ground school training, to actually experiencing the symptoms of hypoxia through altitude chamber training in which participants physically experience decompression.

4.2 **Issues considered by the Advisory Group.**

The 25,000 mean sea level (MSL) altitude determinant found in the regulations

Hypoxia can be experienced while flying at altitudes below 25,000 ft. MSL. Also, the growing number of experimental, high-performance, non-pressurized aircraft which can fly above 25,000 ft MSL may present an additional training challenges. Beginning pilots, who are not required by regulation section 61.31(g) to receive hypoxia training since they would not be flying above 25,000 ft. MSL, may also transition to one of these higher-flying non-pressurized experimental aircraft without the benefit of formal hypoxia training.

Related to this is the differences between certain regulatory parts. While 14 CFR Part 91 [section 91.211(a)(1)] requires the use of supplemental oxygen above 12,500 ft. MSL, Part 61 [section 61.31(g)] does not require training in loss of oxygen and subsequent hypoxia unless the pilot flies above 25,000 ft MSL in a pressurized aircraft. The Committee discussed whether this discrepancy constituted an oversight in regulatory policy.

Dangers of altitude chamber training

Injury during altitude chamber training can be reduced by standard precautions. The methodology employed by the Air Force includes clearing all applicants before training; completing a preflight checklist on the day of training; a 5,000 ft. MSL ear and sinus check to evaluate readiness; and 30 minutes of sustained 100% oxygen to prevent decompression sickness.

The Air Force reports that 3.5% of participants experience some ear/sinus problems during the decompression flight. 0.15-0.31% of all participants experience decompression sickness. The majority of the latter cases are treated with ground level oxygen treatment and can be returned to flight duty within 72 hours.

The FAA's altitude training program has noted differences in physical attributes for civilian pilots vs. military pilots, such as age, weight and overall physical condition. Accommodations in its altitude chamber training include two profiles that are used based on testing of applicants. For example, Profile B screens participants experiencing trapped gases at 10,000 ft MSL.

The Committee concluded that injury during altitude training is not a problem that would warrant additional precautions or limiting recommendation of this training.

Additional awareness by the aviation medical examiner (AME)

The Committee discussed that the AME may play a special role in encouraging pilots to seek altitude and hypoxia training. Moreover, the AME should be made more responsible for identifying pilots who may be a high risk because of a special medical condition and counsel those pilots as to their possible higher susceptibility to hypoxia-induced incapacitation and those hazards associated with hypoxia.

5. Accidents and Incidents

One of the difficulties in the past of identifying accidents caused by hypoxia is that accident reports simply identified "incapacitation", which could have been due to a stroke, heart attack, etc., in addition to hypoxia. Only on close examination of the actual details of the report is it possible to identify hypoxia as the "cause" or a "factor" in the accident. Still, this is subject to interpretation. The literature examined by the Committee included the following data.

656 in-flight incidents of hypoxia were reported to the USAF Safety Center between January 1876 and March 1990. Of the 606 cases involving chamber trained aircrew, only 3.8% experienced an in-flight loss of consciousness, while the untrained group of 50 had a LOC of 94%.[1]

AOPA reported to the Committee that a search of the NTSB database, only 19 hypoxia-related GA accidents were found since 1983. Of those, 11 listed hypoxia as the "cause" and 8 as a "factor". Five of the 19 accidents included pressurized aircraft: one involved flight in an aircraft with a known pressurization deficiency and no use of oxygen; one involved an aircraft with a skydiving aircraft with a known faulty door seal; one involved shattered windshield due to hail in a know storm area; one involved probable de-pressurization through the improper use of procedures; and one involved an aircraft with unresolved oxygen issues and a 12,500 ft. mean sea level flight restriction. All 19 accidents involved either fatalities or serious injuries.

The FAA's Civil Aerospace Medical Institute (CAMI) investigated hypoxia-related accidents for Part 91, 135, and 121 that occurred between 1985 and 1999 by querying the NTSB database. Search terms used included "hypoxia," "decompression," and "trapped gas." It found 50 altitude-related events: 19 involved physiological issues, 18 were primarily decompression cases without significant medical or physiological impact on the flight crew, and 13, on further examination, were shown not to be related to hypoxia. The complete CAMI report is found at Tab C.

6. Training

Training Facilities

Since 1962, physiological training has been available to FAA flight crews, civil aviation pilots, and FAA aviation medical examiners at the FAA's CAMI in Oklahoma City. The curriculum consists of 5-6 hours of classroom instruction in aviation physiology subjects and an altitude chamber flight with rapid de-pressurization [8 to 18,000 ft.mean seal level (MSL)] and hypoxia (25,000 ft.MSL). Two profiles are used for the altitude portion of the training: Profile A lasts approximately 45 minutes and involves more rapid climb (to 30,000 ft. MSL) and descent patterns; Profile B lasts approximately 35 minutes and involves a more sustained flight at 25,000 ft MSL. During the 23-year reporting period, 1965-1989, 12,759 students were exposed to these training profiles. Common adverse reactions were aerotitus (882 cases) and aerosinusitis (200 cases). Only 1 student lost consciousness over this period. The report is found at Tab D.

Through an agreement between the Air Force and FAA, aviation physiology courses are available at 15 Air Force bases throughout the United States. These are 1-day courses and the cost is $50. Applicants are screened for potential adverse effects of the training beforehand. Altitude chamber training is included in the 1-day course.

In addition, the Committee discussed that altitude training and hypoxia awareness courses are available at many flight training colleges and institutes. These courses are complete with the altitude chamber training. Because an increasing number of pilots are being trained *ab initio*, these courses are considered entirely adequate for hypoxia and other physiological dangers and have been considered comparable to hypoxia training obtained through FAA and military sources.

Videos

The following videos are available through a company in Oklahoma. Each is about 15 minutes; cost is $20.00.

Physics of the Atmosphere
Hypoxia
Self-Imposed Stress
Altitude-Induced Decompression Sickness
Fit for Flight
Ups and Downs of Cabin Pressurization
Respiration and Circulation
Hyperventilation
Trapped Gases
General Aviation Oxygen Equipment
Motion Sickness
Vestibular Disorientation

Changing nature of the pilot population

One factor to be considered in the training issue is the downsizing of the military pilot population and the expectation that the future pilot pool of new hires will have

civilian rather than military experience. This plays a role in any consideration of the percentage of pilots that have actually had altitude/hypoxia training. While such training is mandatory for military pilots, to include altitude chamber training, civilian pilots may have received only minimal training in the early years of their flight experience. Likewise, recurrent training, while mandatory for military pilots, is not mandatory for civilian pilots. As civilian pilots with only minimal training in hypoxia and other physiological conditions of flight advance to more sophisticated aircraft, their former training may have become too stale to alert them to a possible decompression emergency.

Age as a consideration of susceptibility to de-pressurization problems should also be considered. While military pilots generally retire at relatively early ages, civilian pilots may continue to fly into their latter years. There was some discussion on the increasing effects of hypoxia with the aging process, especially those with permanent damage to the human body.

Operational considerations

A report to the Committee from the Regional Airline Association concluded that most regional carriers' training specific to hypoxia consists of approximately 1 hour.

Pilot Surveys

A survey by Bombardier Aerospace received responses from 72 male pilots, the average age of which was 46. Average total flight hours for this group of pilots were 8,823, and during the last 6 months, these pilots flew an average of 165 hours. Sixty eight of these pilots had received some form of hypoxia training; 48 of them in an altitude chamber. When asked the question "Should all pilots receive basic hypoxia training?" 42 strongly agreed, and 25 agreed. To the question "Should all pilots receive initial altitude chamber training?" 41 strongly agreed and 24 agreed. To the question "Are the current regulations sufficient?" 3 strongly agreed, and 32 agreed. 18 disagreed, and 17 strongly disagreed.

In a follow-up survey done by NBAA, 111 responses were received. Average total flight hours for these pilots was 7,843 hours, with an average of 161 hours in the past 6 months. To the question, "Should all pilots received hypoxia training?" 59 strongly agreed; 40 agreed. To the question, "Should all pilots receive altitude chamber training?" 50 strongly agreed; 28 agreed. 23 of these pilots strongly disagreed that the current regulations are sufficient; 31 disagreed.

From these surveys, it appears that most pilots recognize the benefit of hypoxia training and that there exists some concern with the current regulations.

These two pilot surveys are found at Tab E.

7. Considerations and Conclusions

The Committee's focus was on the adequacy of the current regulations. First, if the current regulations are not sufficient, what should be changed to ensure a sufficient level of safety? The Committee began with a discussion that the ideal scenario would be that all pilots receive not only ground training in hypoxia, but altitude chamber training as well. However, it recognized the obvious impracticality of this approach and examined less burdensome alternatives.

One approach was by "altitude". Since hypoxia can occur at altitudes below 25,000 ft. mean sea level (MSL), then it would be logical to pursue require training for aircraft that would be flown at those lower altitudes. Hypoxia can have a somewhat detrimental effect on the human physiology at night at or above 5,000 ft MSL. However, the FAA and most regulatory agencies allow for a maximum cabin altitude of 8,000 ft. without pressurization since it is generally accepted that a person functions normally at this altitude. What altitude, then, should be considered as the point for which training is mandatory?

A second approach considered was the "pilot certificate". Which class of pilot certificate should be excluded from mandatory training? Certainly, a private pilot could find the occasion to fly at altitudes above 25,000 ft MSL in non-pressurized aircraft. A recreational pilot is restricted to altitudes below 10,000 ft. MSL. Should these pilots receive mandatory training? Certainly, the regulations could be amended to require mandatory ground training for all pilots. The Committee discussed the ramifications in terms of benefits, incentives, and costs to such a regulatory change.

The Committee considered accident data that would support a regulatory change. Out of the approximately 38,000 general aviation accidents that have occurred during the past 20 years, approximately .05% (five hundredths of one percent) involved hypoxia. This percentage of hypoxia-related accidents was deemed by the Committee to be very insignificant and that number of hypoxia-related accidents could not support a recommendation for a regulatory change.

The Committee also considered the adequacy of the current available training. Is sufficient training readily available? The Committee ascertained a positive response to this question. Through many Air Force sites, CAMI, and universities and flight training institutes, pilots can receive hypoxia training, both ground and altitude chamber training, and participate in instruction in other physiological illnesses and conditions for as little as $50.00 and complete the training in one day. Moreover, refresher/recurrent training is highly promoted through programs offered through various aviation industry organizations and the FAA's "Wings Award" Program.

The Committee found that there are multiple ways that the current training scenario could be improved. Some FAA reference materials are either obsolete or out of date, or are incorrectly referenced. More incentive programs should be made available free of cost to established pilots as refresher training. This will require cooperation between the FAA and industry organizations and will require additional funding to make training materials available to pilots.

[1]*Analysis of USAF Hypoxia Incidents January 1976 Through March 1990,* Richard T. Island and Earl V. Fraley, University of North Dakota.