The FAA Altitude Chamber Training Flight Profile: A Survey of Altitude Reactions - 1965-1989

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16. Abstract

Reactions from 1,161 trainees out of 12,759 trainees subjected to the FAA altitude chamber training flights from 1965-1989 are annotated in this survey. Although there were some mild and expected reactions, these training profiles appear to provide a safe learning environment without compromising the student's health and safety. Inside chamber instructors did not fare as well, perhaps due to age and cumulative number of exposures, and recommendations are suggested for improved safeguards.

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THE FAA ALTITUDE CHAMBER TRAINING FLIGHT PROFILES: A SURVEY OF ALTITUDE REACTIONS - 1965-1989

INTRODUCTION

Since 1962, physiological training has been available to the aviation populace at the Federal Aviation Administration's (FAA) Civil Aeromedical Institute (CAMI) in Oklahoma City, Oklahoma. The curriculum consists of five to six hours of classroom instruction in aviation physiology subjects and an altitude chamber flight with rapid decompression. Students may consist of flight attendants, engineers, student pilots, flight examiners, and airline flight crews.

Participants in the altitude chamber must meet the following requirements:

1. Minimum age of 18 years (no maximum age limit).
2. Students may not wear beards.
3. Students must be free from colds or allergies and have no afflictions that could be aggravated by atmospheric pressure changes.
4. Students must hold a valid FAA Medical Certificate.
5. An Assumption of Risk and Treatment statement must be signed.

Three classes of medical certificates are issued by the FAA based on medical standards established by law and contained in the Federal Aviation Regulations (FAR) Part 67 (14 CFR 67) (2). First class certificates are required for airline transport pilots, second class certificates for commercial pilots, and third class certificates for private and student pilots.

First class medical certificates require an electrocardiogram (EKG) at age 35 and annually after age 40. EKGs are not standard requirements for second and third class certificates. Except when additional medical information is required, serum chemistry tests are not required for certification in any of the three classes.

ALTITUDE CHAMBER INSTRUCTORS

Four instructors are required to operate an FAA altitude chamber flight: a chamber operator, a flight recorder, and two inside observers; also, a flight surgeon must be on telephone standby. The inside observers who participated in these series of training flights are all ex-U.S. Air Force chamber technicians with many years of altitude chamber experiences. Three of the four instructors have been participating for over 30 years in exposures to reduced atmospheric pressure. All inside observers possess a current

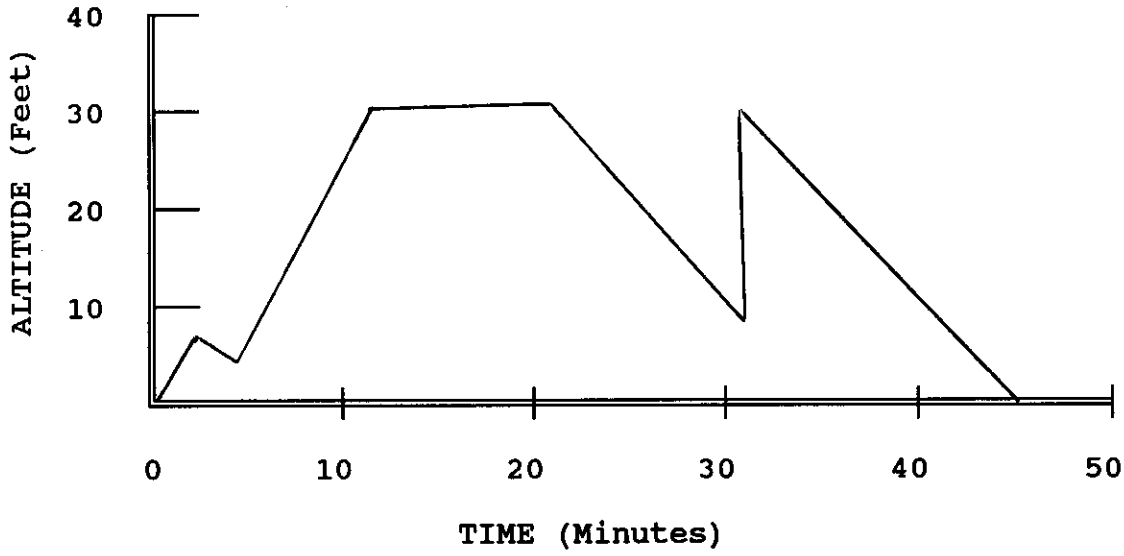
FAA second class medical certificate, which is valid for one year. Maximum exposures are in accordance with U.S. Air Force Regulation (AFR) 50-27 (3) which permits two rapid decompressions in a 7 day period with at least 24 hours between exposures to rapid decompression. Routinely, all inside observers received the maximum exposure permitted during this 23 year period. On every training flight, inside observers are subjected to an altitude chamber flight and rapid decompression.

METHODS

During the 23 years cited in this report, the following profiles were conducted:

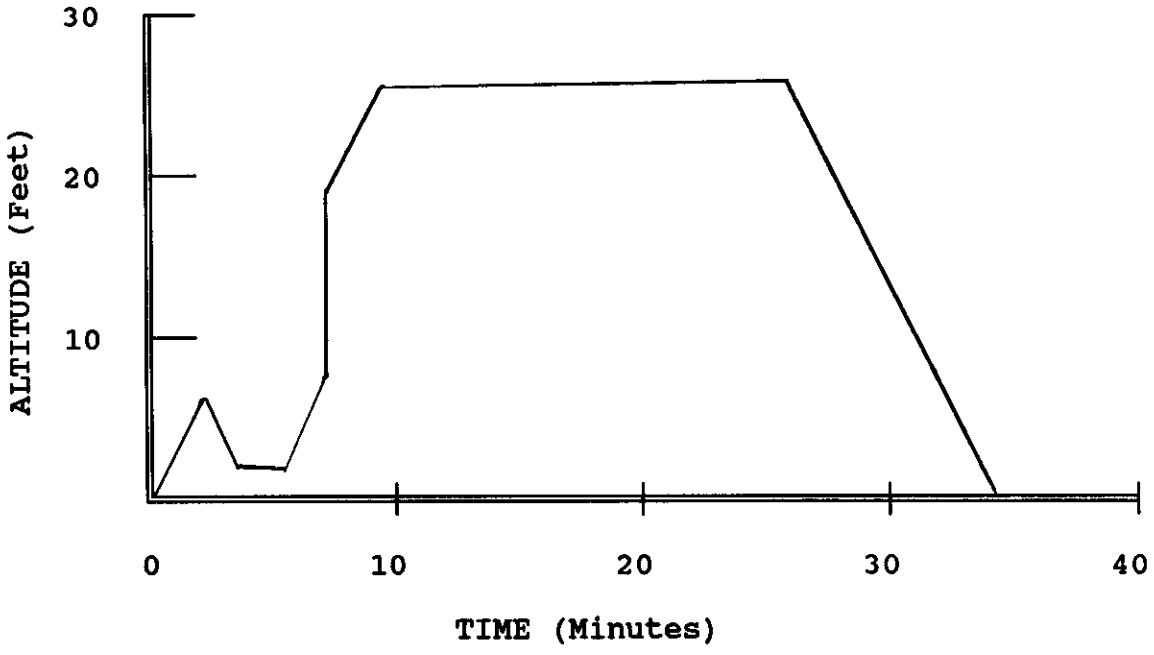
Altitude Chamber Flight Profile Type A (1965-1971): After a routine medical inquiry of each student's physical condition, the students take assigned seats in the altitude chamber. An evacuation to 7,000 ft (2,133m) at a rate of 3,000 ft (914m) per minute begins. The chamber operator levels the chamber on reaching 7,000 ft (2,133m) and lowers the chamber to 2,000 ft (610m) at a rate of 2,000 ft (610m) per minute. On reaching ground level, any student suspected of being a candidate for sinusitis or aerotitis media is removed from the chamber. The chamber run is then continued, at a rate of 3,000 ft (914m) per minute, to 29,000 ft (8,839m), where the students experience symptoms of hypoxia. Exposure to 29,000 ft (8,839m) averages about 8 minutes. After the demonstration, the chamber returns to 8,000 ft (2,438m) at a rate of 2,000 ft (610m) per minute. The students next experience a decompression from 8,000 ft (2,438m) to 29,000 ft (8,839m) in 20-24 seconds. On arriving at 29,000 ft (8,839m), the chamber descends to ground level at a rate of 2,000 ft (610m) per minute. If pressure breathing equipment is used during the flight, pressure breathing and communication techniques are demonstrated. The total time of the chamber flight averages about 45 minutes. Figure 1 illustrates the Type A Profile.

FIGURE 1. FAA ALTITUDE CHAMBER PROFILE TYPE A



Altitude Chamber Flight Profile Type B (1973-1989): After being medically screened for any predisposing factors that could be aggravated by altitude, acceptable students were seated in the training chamber and taken to 6,000 ft (1,829m) at 3,000 ft (914m) per minute. The chamber was returned to 2,000 ft (610m) at a rate of 3,000 ft (914m) per minute. Students suspected of having trapped gas problems or exhibiting unsuitable psychological manifestations were removed from the flight and these reactions are included in Table 1. The chamber was next evacuated to 8,000 ft (2,438m) at a rate of 3,000 ft (914m) per minute. Quick don oxygen masks were in the hanging position next to each student. Decompression was initiated to 18,000 ft (5,486m) during a 5 second time period. After students donned their masks, the chamber continued to 25,000 ft (7,620m) for the hypoxia demonstration. Students experiencing hypoxia at 25,000 ft (7,620m) were restricted to a maximum time of 5 minutes without supplemental oxygen. After the hypoxia demonstration, the chamber was returned to ground level at a rate of 3,000 ft (914m) per minute. Pressure breathing and voice communication against positive pressure were practiced by each student on the descent. Average flight time was 34 minutes. Denitrogenation was not a prerequisite for these flights. Figure 2 illustrates the Altitude Chamber Training Profile Type B.

FIGURE 2. FAA ALTITUDE CHAMBER PROFILE TYPE B. (1973 - 1989)



RESULTS AND DISCUSSION

During the 23-year reporting period, 12,759 students were exposed to these training profiles. A total of 1,503 training flights were conducted. Recorded altitude chamber reactions were: aerotitis media (N=882), aerosinusitis (N=200), aerodontalgia (N=20), hyperventilation (N=15), abdominal distress (N=19), claustrophobia (N=2), suspected decompression sickness (N=10), apprehension (N=9), tingling (N=3), and unconsciousness (N=1) for a total of 1,161 reactions. Table 1 enumerates the altitude chamber reactions.

TABLE 1 - FAA ALTITUDE CHAMBER REACTIONS

SYMPTOM	PROFILE TYPE A (1965-1971)* 479 Flights 3,034 Students	PROFILE TYPE B (1973-1989)* 1,024 Flights 9,725 Students	TOTAL
Aerotitis Media	248	634	882
Aerosinusitis	81	119	200
Aerodontalgia	6	14	20
Hyperventilation	3	12	15
Abdominal Distress	5	14	19
Claustrophobia	2	0	2
Decompression Sickness	2	8	10
Apprehension	0	9	9
Tingling	0	3	3
Unconsciousness	0	1	1
			1,161

*Data from the years 1972 and 1985 were not available.

The three reported cases of tingling occurred following pressure breathing and may have been related to hyperventilation. During a hypoxia demonstration at 22,500 ft (6,858m), one student lost consciousness one minute and 54 seconds into the demonstration. He remained unconscious during the emergency descent until the chamber reached an altitude of 8,000 ft (2,438m).

Decompression sickness reactions were suspected on ten flights with inside observers accounting for most of the reactions. Table 2 illustrates the reactions.

TABLE 2 - FAA DECOMPRESSION SICKNESS REACTIONS
SUSPECTED DECOMPRESSION SICKNESS

STUDENTS

SYMPTOM	ALTITUDE	RESULTS
Elbow Pain	25,000 ft (7,620m)	Relieved at 24,000 ft (7,315m)
Ankle Pain	23,000 ft (7,010m)	Relieved at G.L.
Shoulder Pain	18,000 ft (5,486m)	Relieved at 10,000 ft (3,048m)

INSIDE OBSERVERS

SYMPTOM	ALTITUDE	RESULTS
Joint Pain	29,000 ft (8,991m)	Relieved at 27,000 ft (8,229m)
Wrist Pain	28,000 ft (8,534m)	Relieved at 22,000 ft (6,705m)
Knee	25,000 ft (7,620m)	Relieved on descent
Parasthesia (foot)	23,000 ft (7,010m)	Relieved at 13,000 ft (3,962m)
Shoulder	25,000 ft (7,620m)	Grounded
Neck, Arm and Shoulder Pain (several episodes)	25,000 ft (7,620m)	Grounded

One inside observer, with over 30 years of participation in altitude chamber exposure, experienced two reported and several undocumented episodes of neck, shoulder, and arm pain over a two-year period. Dull chronic pain over these areas of the body intensified with increased frequency of exposure. Parasthesia and elevated levels of pain would persist for 2 or 3 days following each exposure to altitude. Orthopedic and neurologic evaluation of this individual resulted in these findings:

(1) 75% flexion, extension and rotation of his neck with pain on forced neck rotation.

(2) 1 + hypoactive left biceps reflex.

(3) Plain X-ray evidence of marked narrowing of the disc space at C6-C7 and narrowing of the C7 root foramen.

(4) Plain X-ray evidence of narrowing of the L5-S1 disc space.

(5) Magnetic Resonance Imaging scan showed no nerve root compression in the cervical spine. Slight bulging of the L5-S1 disc was not considered severe enough to warrant surgical treatment.

(6) Neurological examination was normal except for intermittently depressed left biceps tendon reflex as above.

(7) Nerve conduction velocities and electromyogram were normal, showing no significant neuromuscular damage.

This inside observer has been restricted from any future altitude chamber flight on the basis of cervical radiculopathy with clear-cut symptomatology aggravated by altitude.

Another inside observer with over 30 years of participation in altitude chamber flights experienced shoulder pain at 25,000 ft (7,620m) during a research chamber flight. The chamber profile for this flight was similar to the training flight, except for a 3 minute stop at 15,000 ft (4,572m) on the way to 25,000 ft (7,620m) and a 3 minute stop at 15,000 ft. (4,572m) on the way to ground level. Denitrogenation was not included in the protocol and total flight time was 46 minutes including 4 minutes at 25,000 ft (7,620m). Pain persisted after the flight and skin mottling was evident the following morning. This inside observer continued to have soreness and pain for the next two weeks and was referred to the aviation medicine experts for evaluation. Bone necrosis was not found, but he was diagnosed as having tendonitis and bursitis with the impression that years of repeated episodes of untreated limb bends may have contributed to the development of a painful shoulder. He also was restricted from any future altitude chamber flights.

Examination of the data suggests that although some students did experience mild and expected altitude reactions, these training profiles appear to provide a safe learning environment while meeting the training needs of the aviation public. Considering the nominal medical requirement, unknown physical condition of students, different levels of student experience, and the minor reactions cited, continuation of the profiles is indicated.

CONCLUSIONS

Although there were some mild and expected reactions from chamber trainees, the training profiles appear to provide a safe learning environment without compromising the student's health and safety. However, data from the older inside observers used in these chamber flights tend to raise several questions. These include:

1. Will age contribute to the susceptibility to decompression sickness?

2. On a weekly basis and over a period of many years, will rapid decompressions and altitude exposures to 25,000 ft (7,620m) and above predispose an individual to orthopedic or neurological problems during the latter years of life?

3. Over a period of many years, will frequency and duration of altitude exposure, as defined in this report, adversely effect respiration and circulation, the digestive system, hearing and other body systems?

4. Does altitude exposure offer any beneficial effects on the body systems?

If future research should support the premise that age and long-term exposure to altitude have a deleterious effect on the body, then different safeguards may be needed for senior inside observers. Some safeguards to be considered may include:

1. An age limit or years of exposure limit for inside observers.

2. A modified weekly maximum exposure level for inside observers that considers long-term exposure and upper-age range.

3. Continuation and expansion of an annual routine physical examination to include a preventive program, which may incorporate a cardiac stress test, periodic X-rays of the chest and major joints, a pulmonary function test, and serum chemistry.

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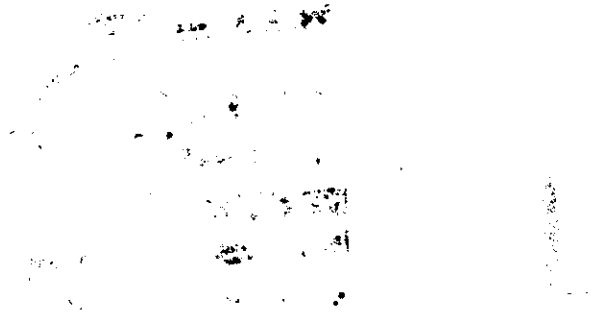

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