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TEN-YEAR SURVEY OF ALTITUDE CHAMBER REACTIONS USING THE FAA TRA--ETC(U)
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TEN-YEAR SURVEY OF ALTITUDE CHAMBER REACTIONS USING THE FAA TRAINING CHAMBER FLIGHT PROFILES

Charles D. Valdez
Civil Aeromedical Institute
Federal Aviation Administration
Oklahoma City, Oklahoma

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16. Abstract

The Federal Aviation Administration since 1962 has trained nonmilitary government-employed flightcrews and civilian pilots in the aspects of altitude and its effects on the human body. The standard military altitude chamber flight profile was not used and the reasons are explained. Two different chamber profiles were used for a 10-year period and both included a rapid decompression, but the altitudes attained were limited to 25,000 ft (7,620 m) and 29,000 ft (8,839 m). During the 10-year period cited in this report, 4,759 students were exposed to these altitudes and none experienced an evolved gas problem.

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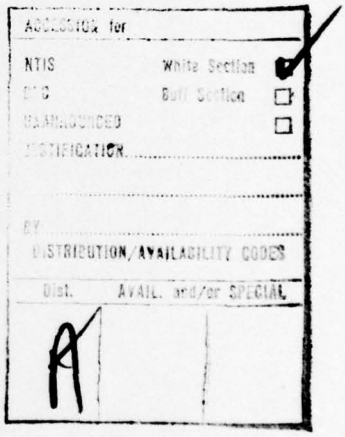

TEN-YEAR SURVEY OF ALTITUDE CHAMBER REACTIONS USING THE FAA TRAINING CHAMBER FLIGHT PROFILES

I. Introduction.

Since 1962 the Federal Aviation Administration (FAA) has provided physiological training for nonmilitary government-employed flightcrews and civilian pilots. This training program is designed to acquaint flight personnel with the physiological hazards of flight, specifically hypoxia, hyperventilation, sensory illusions of flight, and decompression problems.

In developing a training program appropriate to the civilian population, the FAA considered adopting the training syllabus of the United States Air Force physiological training units. This training, described in AF Regulation 50-27 (1), comprises 12 hours of classroom work and experience in a decompression chamber. The Air Force typically exposes its students to a maximum altitude of 43,000 ft (13,106 m), including a 2- to 3-s decompression in which the student experiences an increase in effective cabin altitude from 8,000 ft (2,438 m) to 22,500 ft (6,858 m).

Although the Air Force training program has been very effective for military needs, it may not be the appropriate approach for civilian pilots. Specifically, the FAA position is that in the design of the chamber experience for civilians, careful consideration should be given to problems that may arise with respect to decompression sickness because of the differences in age, weight, and physical condition among the civilian population.

In comparison to civilian pilots, who range in age from 15 to 86 years (2), the USAF student group participating in the chamber flight is composed of individuals 21 to 66 years of age (personal communication with Life Sciences Division, 1973, Norton Air Force Base, California). Although it does not significantly influence hypoxia (3), age has been identified as influencing individual susceptibility to decompression sickness. This evidence further suggests a lowering of the altitude attained in order to reduce the possibilities of an evolved gas problem.

Weight also may contribute to susceptibility of decompression sickness. Air Force Manual 160-10-4, Physiology of Flight (4), states that one of the factors contributing to the incidence of decompression sickness is the relationship of age to body build (measured by surface or weight-height ratio). In general, the occurrence of symptoms increases with age, body surface, and the ratio of weight to height. The youngest and smallest man would appear to be the best able to remain free of bends on long flights at high altitudes. Because of these factors, strict controls are employed to maintain normal body weight of military flightcrews. In comparison, excessive weight is not a disqualifying factor in obtaining an FAA medical certificate.

It is also a premise that 30,000 ft (9,144 m) is the critical altitude for decompression sickness. Military studies have shown that for each 100 man-hours at 25,000 ft (7,620 m), there will be one instance of decompression sickness serious enough to cause abortion of a mission and about 10 instances not serious enough to require termination of the flight. At 30,000 ft (9,144 m), the rate increases to 3 intolerable and 30 tolerable instances per 100 man-hours (4).

Finally, the possible time allowed to exist between physicals is questioned. An FAA Class I certificate reverts to Class II after 6 months. This Class II certificate can revert to Class III after a year. A Class III certificate is valid for 2 yr from the month of issue. Neither a Class II nor a Class III certificate requires an electrocardiogram. Thus, when one considers the combinations that may develop, it would not be impossible to have an overweight, 74-year-old student with a 2-year-old physical scheduled for a chamber flight to 43,000 ft (13,106 m).

In consideration of all these factors, a fairly mild chamber profile for civilian personnel is warranted. This author is in full agreement with a recent publication (5), which states that altitude training should not be an experience in survival but should be done for the purpose of training individuals. By limiting the altitude to less than 30,000 ft (9,144 m) and extending decompression over a longer time span, the chamber exposure will be less hazardous to the wide variety of people being trained. This profile can still provide the desired experiences of hypoxia. The purpose of this paper is to report the results of two chamber flight profiles during two time periods: January 1965 - December 1971 and January 1973 - December 1975. The results for chamber flights conducted in 1972 are not included in this report as the records were destroyed before the information could be compiled.

II. Methods.

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 (2,133 m) at a rate of 3,000 ft (914 m) per minute begins. The chamber operator levels the chamber on reaching 7,000 ft (2,133 m) and lowers the chamber to 2,000 ft (610 m) at a rate of 2,000 ft (610 m) per minute. Any student suspected of being a candidate for sinusitis or aerotitis media is removed from the chamber on reaching ground level. The chamber continues, at a rate of 3,000 ft (914 m) per minute, to 29,000 ft (8,839 m), where the students experience symptoms of hypoxia. Exposure to 29,000 ft (8,839 m) averages about 8 min. After the demonstration, the chamber returns to 8,000 ft (2,438 m) at a rate of 2,000 ft (610 m) per minute. The students next experience a decompression from 8,000 ft (2,438 m) to 29,000 ft (8,839 m) in 20-24 s. On arriving at 29,000 ft (8,839 m), the chamber descends to ground level at a rate of 2,000 ft (610 m) 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 min.

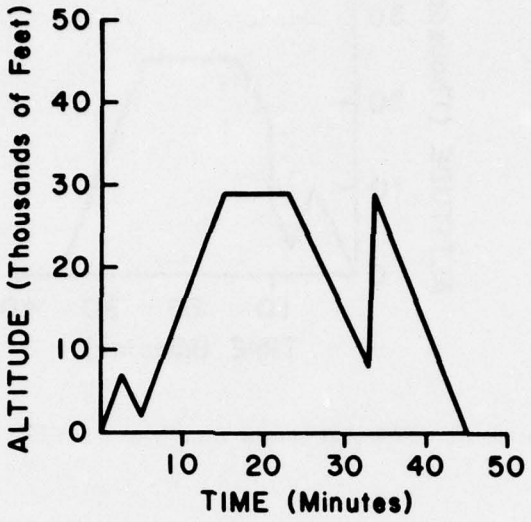

Figure 1. FAA Altitude Chamber Profile Type A.

Altitude Chamber Flight Profile Type B (1973-1975): After the medical inquiry and seat assignment, the chamber is evacuated to 10,000 ft (3,048 m) at a climb rate of 2,000 ft (610 m) per minute. The operator levels at this altitude and returns it to 3,000 ft (914 m) at a descent rate of 2,000 ft (610 m) per minute. Suspected candidates for trapped gases are refrained from further exposure. The chamber is next evacuated to 8,000 ft (2,438 m) at a rate of 2,000 ft (610 m) per minute, with the quick-don oxygen mask in the hanging position next to each student. A decompression is initiated to 18,000 ft (5,486 m) over a 10- to 12-s period. After mask donning by the students and oxygen flow check, the chamber continues at a rate of 2,000 ft (610 m) per minute to 25,000 ft (7,620 m), where the students experience symptoms of hypoxia. Maximum time without supplemental oxygen during the hypoxia demonstration is limited to 5 min per student. After the hypoxia demonstration, the chamber returns to ground level at a rate of 2,000 ft (610 m) per minute. Pressure breathing technique and communication with pressure breathing is practiced during the descent. The time of the chamber flight using profile B averages about 35 min.

Figures 1 and 2 show the FAA chamber flight profiles and Figure 3 illustrates the USAF Type II chamber flight profile.

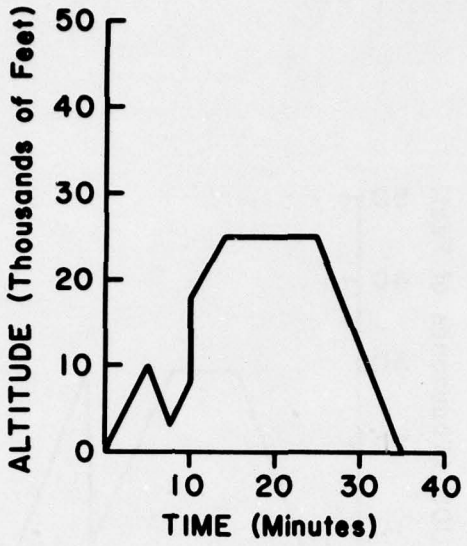

Figure 2. FAA Altitude Chamber Profile Type B.

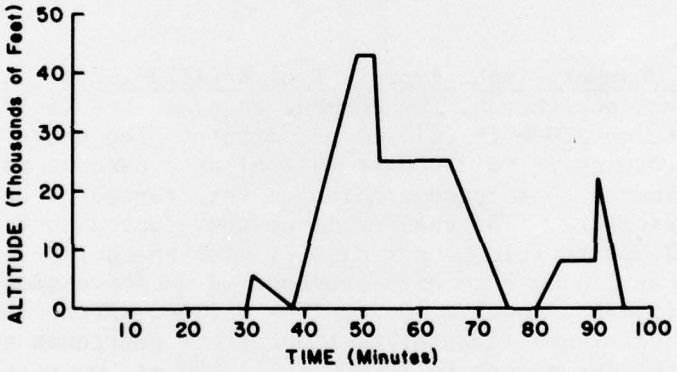

Figure 3. Typical USAF Type II Chamber Flight and Rapid Decompression.

III. Results of the FAA Altitude Chamber Flight Profiles.

Table 1 shows that of 3,034 students trained with profile type A from January 1965 to December 1971, only 345 students experienced reactions and all of these were minor. A total of 479 chamber flights were conducted. The chamber used during most of these flights accommodated only six students.

Table 1 also includes 133 minor reactions from 1,725 students trained with profile type B from January 1973 to December 1975. In this 3-yr period, 194 chamber flights were conducted. Compilation of data from profile types A and B in this 10-yr period shows a total of 673 chamber flights conducted with 4,759 students exposed. Minor reactions of aerotitis media (N = 354), aerosinusitis (N = 100), hyperventilation (N = 6), aerodontalgia (N = 6), abdominal distress (N = 6), and claustrophobia (N = 6) totaled 478. Table 2 is included for comparison.

Berry's (6) report shows that evolved gas manifested Grade III pain in 161 subjects and Grade IV pain in 27 subjects. Students trained on the FAA flight profiles did not develop a single case of evolved gas reaction although denitrogenation was not done on any of these flights. Two chamber technicians experienced bends of the wrist and shoulder in this 10-yr period. The technicians, retired Air Force personnel employed by the FAA, experienced the wrist and shoulder incidents at 28,000 ft (8,533 m) and 29,000 ft (8,839 m) respectively. Further investigation of the FAA chamber flight recordings revealed an interesting paradox. According to publications concerned with proneness to evolved gas, another retired Air Force chamber technician should have been a good candidate for evolved gas problems, as he was in his late 40's and early 50's during these chamber flights and also overweight by about 100 lb (45.5 kg). This subject did not manifest a single instance of decompression sickness in this reporting period. He is a pioneer in the physiological training program, having participated since 1942. The FAA chamber flight profiles in use during this time could have been a factor contributing to the lack of any decompression sickness reaction in this individual.

Table 1. Chamber Flight Reactions of Students at the FAA Civil Aeromedical Institute (673 chamber flights with 4,759 students)

SYMPTOM	PROFILE TYPE A 1965-1971 479 FLIGHTS, 3,034 STUDENTS	RATE PER 100,000 MAN-FLIGHTS	PROFILE TYPE B 1973-1975 194 FLIGHTS, 1,725 STUDENTS	RATE PER 100,000 MAN-FLIGHTS	TOTAL	TOTAL PER 100,000 MAN-FLIGHTS
Aerotitis media	248	8,174	106	6,145	354	7,439
Aerosinusitis	81	2,670	19	1,101	100	2,101
Hyperventilation	3	99	3	174	6	126
Aerodontalgia	6	198	0	0	6	126
Abdominal distress	5	165	1	58	6	126
Claustrophobia	2	66	4	232	6	126
Bends *	0	0	0	0	0	0
Chokes	0	0	0	0	0	0
Central Nervous System Disturbance	0	0	0	0	0	0

* Bends was experienced by inside chamber observers on two occasions.

Table 2. Symptoms by Grade in 51,580 Man Chamber Flights, 1955 (numbers per 100,000 man flights) (6)

SYMPTOM	GRADE OF REACTION				TOTAL
	I	II	III	IV	
Aerotitis media	6,650	2,437	514	0	9,601
Aerosinusitis	1,516	723	176	0	2,415
Aerodontalgia	285	142	118	0	545
Abdominal distress	2,738	1,187	322	12	4,259
Bends	1,594	642	155	21	2,412
Chokes	47	19	0	2	68
Central Nervous System Disturbance	12	6	6	4	28
Other	432	167	178	54	831

IV. Conclusion.

The experience gained from these flights tends to support the belief that 30,000 ft (9,144 m) is the critical altitude for decompression sickness. Also, lack of physical activity and a short exposure time at 29,000 ft (8,839 m) and 25,000 ft (7,620 m) are conducive to decreasing the possibility of an evolved gas problem.

This report should not be construed to mean that any chamber flight other than FAA profile type A or B is not a safe training flight. However, working in the parameters of rules and regulations of civilian aviation, the FAA believes its chamber flights were more advantageous to all concerned. These flights provided a comfortable physiological and psychological learning environment and, at the same time, did not compromise the students' health and safety. Students, after participating in these flights, overwhelmingly agreed that they enjoyed the flights and experienced little or no discomfort. They were also of the opinion that these types of chamber flights met the requirements of the civilian pilots, and they felt better prepared to cope with the physiological problems of flight.

The FAA believes their chamber flights provide realism without jeopardizing safety and therefore does not plan to increase the training altitude of these flights.

The United States Air Force, the United States Navy, and the National Aeronautics and Space Administration, through an agreement with the FAA, for many years have provided physiological training for civilian pilots by use of the FAA chamber flight profile type A. It may be of interest to see if these services have had the same excellent results that the FAA has had with this chamber flight profile.

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