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# Hypobaric Training for Royal Air Force Aircrew – An Update

**Sqn Ldr D C McLoughlin MSc MB Bch MRCP DAvMed DRCOG RAF**

Royal Air Force Centre of Aviation Medicine

Royal Air Force Henlow

Bedfordshire

United Kingdom

SG16 6DN

## INTRODUCTION

Until 1998, the Aviation Medicine Training Centre (AMTC) carried out most aviation medicine training for Royal Air Force aircrew at RAF North Luffenham. With the closure of its parent station, AMTC relocated to RAF Henlow in Bedfordshire. At RAF Henlow, it combined with the School of Aviation Medicine from RAF Farnborough, to form the RAF Centre of Aviation Medicine (RAF CAM). The subsequent relocation and refurbishment of the hypobaric chambers, together with the loss of experienced staff, resulted in many challenges for the restoration of hypobaric training at this new unit. This paper states the training requirement, describes the hypobaric chambers, highlights aspects of safety and outlines the hypobaric training profiles and details the results so far.

## TRAINING REQUIREMENT

Hypobaric training is conducted to meet the requirements of STANAG 3114 (1). RAF aircrew undergo hypobaric training before initial flying training, on changing of aircraft type, on returning to flying duties after an absence, and after an interval of 5 years from their last attendance at a formal aeromedical training course. All training is conducted in accordance with the standard operating procedures detailed in the RAF Aviation Medicine Training Memorandum 33 (2)

## HYPOBARIC CHAMBER COMPLEX

Four hypobaric chambers were refurbished and installed at RAF CAM by Aeroform Ltd. Each chamber has seating for up to 10 aircrew and one instructor. There is a large compartment with a total of 9 seats and a separable small compartment with 2 seats. Oxygen is supplied to the chambers at a pressure of 1800 lb/in<sup>2</sup>. This supply is then reduced in pressure to provide 2 separate oxygen circuits capable of supplying a variety of regulator types at each seat position. However, in the future, it is planned to dedicate each chamber to a particular type of oxygen system. Therefore, 2 chambers will be dedicated to fast jet and 1 chamber to transport aircraft oxygen systems. This will leave one chamber for research and specialised high altitude chamber profiles.

Each hypobaric chamber is under manual control. The main valves are pneumatic with interlocks to limit the rates of ascent and descent. For research or other purposes not involving aircrew training these interlocks can be disengaged to permit much faster rates of pressure change. In addition, two, 2 inch valves which may be under either automatic or manual control, provide height hold and cross venting when the chamber is occupied. There is a digital display of the altitude in feet and mmHg, as well as an analogue display of altitude and its rate of change. To accomplish rapid decompressions, an electrically operated isolation valve (which controls the rate of pressure change) and an electrically controlled, but pneumatically operated, butterfly type, rapid decompression valve are utilised. The chambers main electrical supply is supplemented by a battery back up that will last a minimum of 1 hour in the event of a power failure.

A computer monitoring system provides the pressure chamber operator (PCO) with a variety of display screens. These are as follows: initial details, pre-climb checks, recording screen, pre-rapid decompression

checks and the duration of individual hypoxia experiences. All procedures are checked by another PCO on the central console of the chamber complex. The hypoxia run is monitored and recorded by video cameras, which provide a continuous 4-channel display. These show the operating PCO, the small chamber and 2 views of the occupants of the large chamber. A digital tape of each hypobaric training profile is also recorded.

Each hypobaric chamber can be connected to a combination of up to 4 vacuum reservoirs and 4 vacuum pumps. To initiate a climb, the ascent valve, which connects the chamber to the vacuum pumps, is opened. To carry out a rapid decompression, the reservoir tanks are evacuated by the vacuum pumps to the required pressure and the isolation valve is set to control the rate of the decompression. The rapid decompression is subsequently initiated by opening the rapid decompression valve, which connects the chamber to the reservoir tanks.

## SAFETY

Since many of the staff had departed during the relocation of the unit, it was necessary to arrange a programme to train new PCOs and inexperienced medical officers. Aviation medicine specialists, experienced PCOs, and engineering and Aeroform personnel contributed to the training course. The syllabus included lectures, practical instruction and multiple training runs. All the medical officers had completed the Diploma in Aviation Medicine and updated their advanced life support skills. As PCOs gained experience, they moved on to be accredited for rapid decompressions and higher altitude profiles. Staff performance is regularly assessed and any chamber incidents are subject to review by the whole team. Each hypobaric chamber training profile requires one operating PCO, one console PCO, one medical officer and an engineering technician. Additional personnel comprising 2 medical officers, one PCO, one survival equipment fitter and one engineering technician are also readily available, if required.

Adjacent to the hypobaric chambers is an Admiralty Compression chamber Mk1. This provides an emergency facility for the treatment of decompression sickness and other dysbaric illnesses that might result from exposure to altitude in the hypobaric chambers. The compression chamber is capable of a simulated depth of 80 metres and is tested to 18 metres before each episode of hypobaric training. All the medical officers have completed the Navy Underwater Medicine Course, and the PCOs have also been trained in the use of the compression chamber by the Royal Navy. Full emergency treatment facilities are located beside the compression chamber.

## AVIATION MEDICINE INSTRUCTION

As required by STANAG 3114, prior to hypobaric exposure, RAF aircrew receive appropriate instruction in aviation medicine. This includes basic physiological responses to altitude exposure, hypoxia, hyperventilation, hazards of pressure change and decompression sickness. This is followed by a chamber brief on equipment to be used, pre-climb checks, pre-rapid decompression checks, verbal and non-verbal communication, and safety issues. In particular, aircrew are advised of the procedures for the individual hypoxia demonstrations and the need for ear clearing on descent. They then complete a medical questionnaire and have their Eustachian tube function assessed.

## HYPOBARIC CHAMBER TRAINING PROFILES

Hypobaric chamber training profiles are designed to match the aircraft flown. They are as follows:

- a. Initial flying training. Climb to 25 000 feet at 4000 feet/minute.
- b. Fast jet low level. Climb to 8000 feet at 4000 feet/minute, followed by a rapid decompression from 8000 to 25 000 feet in 3 seconds.

- c. Fast jet high level. Climb to 18 000 feet at 4000 feet/minute, followed by a rapid decompression from 18 000 to 45 000 feet in 3 seconds. Then descend to 25 000 feet at 10 000 feet/minute. Students are given experience in pressure breathing at least 16 hours prior to this training profile.
- d. Transport aircraft. Climb to 8000 feet at 4000 feet/minute, followed by a rapid decompression from 8000 to 25 000 feet in 12 seconds.
- e. High altitude training profiles for Canberra and Eurofighter aircrew will be discussed by Wg Cdr Gradwell.
- f. High altitude training profiles are also provided for parachutists and other special groups, as required.

All individual hypoxia demonstrations are conducted, in pairs, at 25 000 feet. The medical officer instructs aircrew to remove their masks and presents them with various tasks. During the hypoxia experience they record their symptoms and continue air breathing until they have experienced their particular initial signs of hypoxia and demonstrated deterioration in their abilities. Each trainee is then instructed to replace his mask and the medical officer inside the chamber may give assistance, as needed. The average duration of exposure to hypoxia is between 2.5 and 3 minutes. Following the hypoxia demonstrations, the chamber altitude descends from 25 000 feet to ground level at 4000 feet/minute. After hypobaric chamber training, aircrew are debriefed on their individual hypoxia demonstrations and advised again of the symptoms of decompression sickness. To limit the risk of decompression sickness chamber time above 18 000 feet is kept to a minimum, and for exposures above 45 000 feet all chamber occupants are required to pre-oxygenate (denitrogenate) by breathing 100% oxygen for 30 minutes before the ascent. In addition, to limit the risk for the training staff, medical officers do no more than one chamber training profile per day.

## RESULTS

In the 3 month period, between June and August this year, 98 courses were held at RAF CAM. 497 aircrew received hypobaric chamber training with individual hypoxia demonstrations. 17 aircrew were unfit for training. No major problems were recorded during this period and no chamber training profile was aborted. There were 13 minor holds of chamber altitude on descent, due to aircrew suffering ear discomfort. These all resolved with the use of otrivine and further attempts at ear clearing. No significant otitic barotrauma was noted on the ground. However, in the last year there has been 1 case of decompression sickness. This occurred in a 30 year old male who complained of left elbow pain and developed a rash on his chest. Of relevance, he was overweight and had previously fractured his left elbow. His symptoms quickly resolved on compression therapy at 18 metres following the Royal Navy Table 61 (intermittent oxygen regime). This gives a rate of 1 per 1000 exposures. During the 5-year period 1983 to 1987 there were 5 cases of DCS giving a rate of 0.4 per 1000 exposures (3).

## CONCLUSION

Hypobaric chambers provide a safe environment in which aircrew may be exposed to hypoxia, pressure changes and rapid decompressions. This provides aircrew with practical experience and engenders confidence in their equipment. Appropriate supporting facilities and fully trained staff are prerequisites. With careful planning and well-motivated staff, new units can be quickly created where staff have the necessary skills to provide hypobaric training for aircrew in as safe an environment as possible.

## REFERENCES

1. STANAG 3114 (1986). Aeromedical training of flight personnel.
2. Aviation Medicine Training Memorandum 33. Standard operating procedures for the conduct of altitude training in the Royal Air Force.
3. Thornton E (1988). The incidence of acute morbidity following exposure in a hypobaric chamber. Dissertation in part submission for membership of the Faculty of Occupational Medicine of the Royal College of Physicians.

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