

FIVE YEAR EXPERIENCE WITH THE UPGRADED DYNAMIC FLIGHT SIMULATOR (HUMAN CENTRIFUGE) FOR EUROFIGHTER /TYPHOON PILOT TRAINING IN THE GERMAN AIR FORCE

Michael Nehring

German Air Force Institute of Aviation Medicine (GAFIAM), Division Aviation Physiology Königsbrück, Königsbrück, Germany

Abstract

Introduction: Fighter Pilots of the German Air Force (GAF) are trained in a modern human centrifuge. The goal of the training is to familiarise them with high acceleration forces (G-Force) and with new Anti-G suits.

Objective: To validate aeromedical training methods for jet pilots in a human centrifuge.

Methods: 135 Eurofighter Pilots (all men, age 33 ± 6 yr) were trained in the last five years. The training goal is to achieve a 9g run for 15 sec with a G-onset of 6g/sec. In total 286 qualification runs were completed. All pilots were monitored by ECG.

Results: All pilots successfully achieved 9g for 15sec, with 6g/sec onset. The resting heart rate one minute prior to the 9g run was 103 ± 17 bpm. The maximum heart rate under 9g was 161 ± 20 bpm. The pneumatic Anti-G protection was very effective.

Conclusion: In the GAF HC Fighter Pilots can familiarise themselves with rapid G-onset, sustained high G-Forces and their new personal G-protection equipment within a realistic and safe environment.

Key words: aviation physiology, human centrifuge, acceleration forces

Introduction

With the introduction of modern fighter aircraft such as Eurofighter having a capability of sustaining 9g_z (gravitation force, z-axis: head to foot) aircrew are operating at the limit of human performance. The pooling effects on blood circulation caused by +G_z create a stagnant hypoxia situation. As a result of a sudden critical reduction of cerebral blood flow pilots could lose consciousness (G-LOC: G-induced loss of consciousness). Effects of +G_z force are dependent upon onset rate (g/s), magnitude (G_z) and duration (s). Human Centrifuges (HC) are used to improve pilot's G tolerance [1].

In 2006 the German Air Force Human Centrifuge (Fig. 1) was upgraded to support the introduction of the Eurofighter/Typhoon in the GAF, a modern fighter aircraft 4th generation. This modernisation provided a more realistic centrifuge training that covered military requirements. Importantly the G-onset was increased up to 6g/sec [2]. The HC is now fully operational and ready for both, basic training and interactive training. In addition to a conventional centrifuge training pilots could use the HC as a dynamic flight simulator. Germany is the only Eurofighter-Nation, which has a High Performance HC available. GAF provides centrifuge training for many other countries.

The aim of the study was to prove if pilots equipped with a new Anti-g suits are able to sustain 9g in a centrifuge under safe medical conditions.

Materials and methods

135 EF-pilots (all men, age 33 ± 6 yr) were trained in this five year period. German EF pilots have to take part in basic training and refresher training courses. In a special simulator the so called Training place for Anti-G-Manoeuvre student pilots could learn how to perform muscle tensing and cyclic breathing (Fig. 2). Performed correctly the effects are preventing the pooling of blood and maintaining pressure in the thorax. These Anti-G straining manoeuvres (AGSM) could provide 4 + G_z of protection. In the first four years of their carrier EF-Pilots have to perform this training yearly and then every four years. The goal is to familiarise them with the new Anti- G-Protection and to achieve a 9 g run for 15 sec with a G-onset of 6g/sec. In total 286 qualification runs were completed. All pilots were monitored by ECG.

A Dynamic Flight Simulation with target chasing in the HC completed the program. In this mode the pilot is in control of stick and throttle (Fig. 3).

Anti-G-Protection was either AEA (Aircrew Equipment Assembly), a pneumatic system which consists of a Full Coverage Anti-G-Trouser and Positive Pressure Breathing for G-Protection (PBG) (n=89) or a hydraulic self regulated suit (LIBELLE) without PBG (n=46).

Pneumatic Anti-G suits are inflated through a G-sensitive valve to give counter pressure to the abdomen, thighs and calves proportional to the applied



Fig. 1. German Air Force Human Centrifuge



Fig. 2. Training Place for Anti-G-Manoeuvre



Fig. 3. Fighter Pilot in the Human Centrifuge

acceleration. Performance of AGSM is very fatiguing and cannot maintain for very long.

PBG (60mmHg at 9g) increases intrathoracic pressure, reduces pilot fatigue and lengthens endurance by reducing the need for voluntary straining [3]. Extended coverage anti-G-trousers provide an adequate support of venous return.

Results and Discussion

All pilots successfully achieved 9g for 15sec, with 6g/sec onset. One pilot equipped with the self regulated hydraulic suit had G-LOC but ultimately he passed the test.

The resting heart rate one minute prior to the 9g run was 103 ± 17 bpm. The maximum heart rate under 9g was 161 ± 20 bpm. Cardiovascular effects of +Gz are a decrease in arterial blood pressure above the heart an increase below the heart. Side effects could be arm/foot pain and petechia ("G-measles, rupture of capillaries in the skin due to high vascular pressure). The high pressure in the arms and feet (depending on the position) is a consequence of the increased pressure of the tissues surrounding in the blood vessels and nerves. The pain is probably due to vascular over distension [4].

Pilots equipped with the pneumatic system complained about arm pain in 12% of all runs. Arm pain was not reported when using the self regulated hydraulic suit. Complaints about foot pain were very uncommon for both systems. In a comparative study both anti G-systems were tested in GAF Human Centrifuge [5].

Conclusion

High-G-Training in the upgraded HC is now well established in the GAF and has shown to be medically safe. Our goal is to improve flight safety and mission efficiency by avoiding G-related health problems during operational flying duty. The Full Coverage Anti-G-Trousers in combination with PBG now used by all EF-Nations has proven to be a very effective Anti-G-protection.

Declaration of interest

The author reports no conflicts of interest.

References

1. Gillingham KK, Fosdick JP. High-G-training for fighter aircrew. *Aviat Space Environ Med* 1988; 59: 12-9.
2. Nehring M. High G- training for Eurofighter pilots. *Wehrmedizin und Wehrpharmazie* 2006; 2: 24-5.
3. Burns JW, Balldin U. Assisted positive pressure breathing for augmentation of acceleration tolerance time. *Aviat Space Environ Med* 1988; 59: 225-33.
4. Linde L, Balldin U. Arm pain among swedish fighter pilots during high + Gz flight and centrifuge exposures. *Aviat Space Environ Med* 1998; 69: 639-42.
5. Stein M. Development of an experimental design for anti-G suits in a human centrifuge. German Federal Ministry of Defence. *Annual Research and Technology Report* 2008; 78-9.

Received: January 04, 2012

Accepted: June 04, 2012

Published: June 29, 2012

Address for correspondence:

Michael Nehring

Steinborner Strasse 43

01936 Königsbrück

Germany

e-mail: MichaelNehring@bundeswehr.org