The +Gzette

Submissions from the International Acceleration Research Workshop Community

Volume 5, Issue 1 May 2005

Inside This Issue

Where and When

This is the 19th anniversary of the International Acceleration Research Workshop conceived by Dr. Russell R. Burton. This year's workshop will be held again during the Aerospace Medical Association Annual Scientific Meeting in Kansas City, Kansas.

The workshop will take place at:

Benton Room, Hyatt Hotel
Thursday, 12 May 2005
12:00 – 14:00

Chairman's message:

Welcome to the 2005 International Acceleration Research Workshop (IARW). This year's newsletter contains activity reports from laboratories/nations as well as progress reports from centrifuge facilities currently being developed or upgraded. I hope that the oral presentations during the IARW will also reflect the plethora of ongoing activities within the field of sustained acceleration. I wish to express my gratitude to all of you who have responded to my repeated pleadings for reports as well as to Wyle Laboratories who have kindly offered to sponsor this year's workshop.

I am looking forward to seeing you all again at the workshop.

Ola Eiken, MD, PhD
IARW Chairman 2005

2005 International Acceleration Research Workshop

Workshop Agenda

- **Welcome**
- **Introductions**
- **Laboratory reports**
- **Special presentations**
  - **News from AMST**
  - **News from ETC**
  - **IARW website**
- **Other presentations of acceleration research related topics**
- **General Discussion Forum**
- **Chair selection 2005**

Japan Air Self-Defense Force
Acceleration Research Letter

Tetsuya Tsujimoto, MD, Senior Flight Surgeon, Maj
Centrifuge Training Section
Aeromedical Laboratory
Japan Air Self-Defense Force (JASDF)

NIRS and Arrhythmias during +Gz, Our Great Concerns Today

Five years have passed since we started to use the New Centrifuge Systems which was made by ETC/Shimadzu. There have been some changes in regulations and training patterns, we use 2 patterns for Under Graduate Pilots and 8 patterns for pilots in Transition Training from a Jet Trainer to F-15J/DJ or F-2A/B.

Now we have two great concerns. First of them is Cerebral Oxygenation Monitoring System by Near Infrared Spectroscopy (NIRS) which has been applied and modified by Dr. Azusa Kikukawa and Dr. Asao Kobayashi of JASDF Aeromedical Laboratory. It has been used as one of monitoring systems in actual centrifuge training. Before exploitation of this system, the only good index of muscle tone of lower extremities is pressure gauge of G-suit gotten via G-hose. But we could not evaluate muscle tone without inflating. Some of our training patterns are done without inflation of G-Suit. Furthermore, those patterns are done in early phase of trainings thus means pilots are not good at AGSM and sometimes result in G-LOC. The NIRS can evaluate even under such conditions and becomes a powerful index of effective AGSM. Even though the system is very useful and a good index for training, there are some rooms for improvement in sampling rate, sensor device, interfaces and so on. It is also required further investigation to predict the G-LOC.

Second is tachy-arrhythmia during +Gz. In Japan, all centrifuge trainees must wear ECG monitor during centrifuge ride. Because supraventricular and ventricular extrasystoles (APCs/VPCs) are sometimes seen under +Gz, we forgive a pair of APCs/VPCs during G loading. But over 3 sequential beats of APCs/VPCs, pilots are grounded and required medical investigation by our regulation. As to Supraventricular tachycardia including some of Atrial fibriration and fluttering, we do electro physiologic study (EPS) and in case of pathologic circuit or cause for arrhythmia is determined, we give radio frequently catheter ablation (RFCA) therapy. This application was started in 1999. There have been 15 pilots suffered from Tachy-arrhythmia during centrifuge training and 13 of them have gone back to flight statues for fighters. One of the rests shows controversial VT. It's very difficult to evaluate so he switched to Rear Jet Pilot with restriction prohibiting solo flight. The other case happened on April 5th, 2005 and he is waiting for EPS.

JASDF Centrifuge Trainer

< Specification >
Arm Span: 7.62m
Onset Rate: 6.0G/sec maximum
Max +Gz: 12G (functional)
9G (training use)
Seat Position: 13 degree seat for F-15J/DJ
30 degree seat for F-2A/B

about 200 pilots are trained per a year

2005 USAF (AFRL/HEPG)
Brook City-Base Report

Paul Werchan, Ph.D

Impact of Selective and Non-Selective Alpha Blockade Agents, Typically Used for Lower Urinary Tract Symptoms, on +Gz Tolerance. Major Steven M. Baughman, M.D. Wilford Hall Medical Center, Major Edith Canby-Hagino, M.D.Wilford Hall Medical Center, Colonel Carol S. Ramsey, D.O., M.P.H. AFRL/HEP, Paul Werchan, Ph.D. AFRL/HEPG, Wayne Isdahl, M.S. AFRL/HEPG. Active duty urologists have been faced with an increasing dilemma of treating our aviators with bladder outlet obstructive symptoms. The USAF currently restricts the use of both finasteride (Proscar®) and alpha blocking medications for treatment of benign prostatic hypertrophy (BPH). The purpose of this study is to determine the impact on +Gz tolerance/endurance of tamsulosin (Flomax®) and terazosin (Hytrin®), respective selective and non selective alpha -adrenergic blocking agents, versus the absence of these medications.

Status: Preliminary results are being presented at ASMA 2005.

Tailored Breathing and Anti-G suit Pressures in Relation to Anthropometric Data and Pressurized Arm Sleeves and Gloves for G-protection. Ulf Balldin, M.D., Ph.D., Wyle Laboratories, Tom Morgan, Ph.D. 311th HSW/PE, Paul Werchan, Ph.D., AFRL/HEPG, Wayne Isdahl, AFRL/HEPG. This work is intended to test whether or not individuals of different stature can benefit from the use of positive pressure breathing during G (PBG) and G-suit inflation schedules tailored to their personal anthropometry. We are also testing the effects of pressurized arm sleeves and gloves on acceleration tolerance.

Status: Study in progress, 7 subjects of 10 planned completed, difficulty identifying centrifuge trained subjects with differing heights.

Pressure Breathing During G without a Counter Pressure Vest. Maj Robert O'Connor, AFRL/HEPG, Ulf Balldin, M.D., Ph.D., Wyle Laboratories, Wayne Isdahl, AFRL/HEPG, Roger Stork L, Ph.D., Wyle Laboratories, Paul Werchan, Ph.D., AFRL/HEPG. This work was intended to test whether positive pressure breathing during G (PBG) without a counter-pressure vest negatively influences comfort and performance during high G. The ability to use PBG without a counter-pressure vest would enable a reduction in the weight and bulk of the current fighter aircrew life support equipment ensemble.

Status: Study was completed. Use of PBG and AGSM together enhances G-tolerance and comfort more than AGSM alone. Elimination of the counter-pressure vest during use of PBG does not hinder an individual's ability to reach +9 Gz or complete a short duration of a simulated aerial combat maneuvers G-exposure. Results are being presented at ASMA 2005.

Plotting the Recovery Pattern of Saccule Function in Healthy Subjects Soon After High +Gz Exposure. Maj Drew M. Horlbeck. MD Wilford Hall Medical Center, Maj Chester P. Barton, MD, Wilford Hall Medical Center, Col Carol S. Ramsey, DO, MPH AFRL/HEP, Lt Jeffrey D. Grale Wilford Hall Medical Center, Col Ben Sierra Wilford Hall Medical Center, Paul M. Werchan, AFRL/HEPG, William R. Ercoline, M Veridian . The purpose of this investigation is to determine the effects of +Gz on the function of vestibular system. More specifically, this research effort aims to establish the normal adaptability, fatigue and recovery process of saccule function due to acceleration-related stresses on the otoliths in pilots and aircrew. A quantification of the normal recovery process will assist in establishing a metric for clinical use when one must make a determination to return a pilot or aircrew member to flight duty after reported episodes of dizziness.

Status: Protocol is in progress; working on methodology to obtain valid vestibular measurements following G exposures.

Effects of Simulated Spaceflight on Virus-Specific Immunity. Raymond P. Stowe, Ph.D. Department of Pathology University of Texas Medical Branch-Galveston, Duane L. Pierson, Ph.D. Chief Microbiologist, Life Science Research Laboratories, NASA-Johnson Space Center. The principal objective of this project is to use hypergravity and bedrest to effectively simulate certain aspects of spaceflight in order to better understand how acute changes in gravitational force affect the human immune system. Previous studies by project collaborators of astronauts have found elevated levels of cortisol after launch and during spaceflight, events involving acute acceleration and microgravity. In addition, significant increases in stress hormones (i.e., cortisol, catecholamines) were found after landing. They have found increased shedding of Epstein-Barr virus (EBV) and cytomegalovirus (CMV), two medically important herpes viruses, during spaceflight along with evidence of decreased cellular immunity. These increases in stress hormones directly correlated with CMV and EBV reactivation. Thus, latent herpes virus reactivation in these astronauts may have resulted from both direct (i.e., stress hormones) and indirect (i.e., decreased immune function) mechanisms stemming from launch and landing acceleration. A ground-based model has been developed (head–down bedrest combined with centrifuge exposures) that simulates the multiple gravitational changes that occur during spaceflight (hypergravity at launch, microgravity during flight, hypergravity at landing). This model system will test the hypothesis that the combined effects of hypergravity and bedrest along with associated physical and psychological stress will decrease virus-specific cellular immunity and reactivate latent herpesviruses.

Status: Completed the first launch (four subjects); awaiting additional subject recruitment.

Tactical Aircrew Integrated Life Support System (TAILSS) Centrifuge Evaluation Barry S. Shender, Ph.D. NAVAIR, Paul Werchan, Ph.D. AFRL/HEPG, Wayne Isdahl, M.S. AFRL/HEPG. The primary goals of the study was to assess the ability of the Aircrew Integrated Life Support System (AILSS) to obtain clear, reliable ECG, EEG, EMG, SpO2, near infrared spectrographic, temperature, humidity, mask pressure, and anti-G suit pressure values during exposure to high +Gz. In addition, we assessed the ability of the AILSS State Risk predictor program (SRP) to control anti-G suit pressure and pressure breathing for G (PBG) for US Navy COMBAT EDGE (NCE) and TAILSS (Tactical AILSS) ensembles. The SRP operated the anti-G equipment under two modes: standard US Navy Combat Edge and with biofeedback. We also assessed the ability of the SRP to detect characteristic physiologic changes associated with "almost loss of consciousness" (ALOC). This portion of the study is a follow-up to the NLOC phase I protocol conducted at Brooks in 2002.

Status: Protocol was completed.

Evaluation of the Suitability of the CSU-13B/P G-suit for Use in the F/A-22. Maj Robert O'Connor, AFRL/HEPG, Wayne Isdahl, AFRL/HEPG, Paul Werchan, Ph.D., AFRL/HEPG, Ulf Balldin, M.D., Ph.D., Wyle Laboratories. The Commander of Air Combat Command requested that the CSU-13B/P G-suit be evaluated as a replacement for the Advanced Technology Anti-G Suit currently worn by F/A-22 pilots. HEPG completed necessary modifications to 25 CSU-13B/P suits (move the suit's inlet hose from the left to the right-hand side and change the hose connector) and evaluated performance when used with the F/A-22 Breathing Regulator Anti-G Valve. HEPG also evaluated performance of the CSU-13B/P when used with an extended inlet hose routed across the ejection seat. That hose routing might allow for use of the 13B/P in its standard configuration (suit inlet hose on the left-hand side).

Status: Study completed. No statistical differences in G-levels were found during relaxed GOR and straining GOR between the different anti-G suit conditions I-III. With condition III (COMBAT EDGE and ATAGS) discomfort level was significantly lower than with condition I (MOD), and heart rate was lower than with I (MOD) and II (STD). No statistical differences were found in discomfort rating between the different anti-G suit conditions I-III, but duration at G was longer and heart rate was lower under condition III than under conditions I and II. The truncated durations (90s max), discomfort or heart rate were not statistically different among the three conditions, but for effort, condition III yielded lower scores.

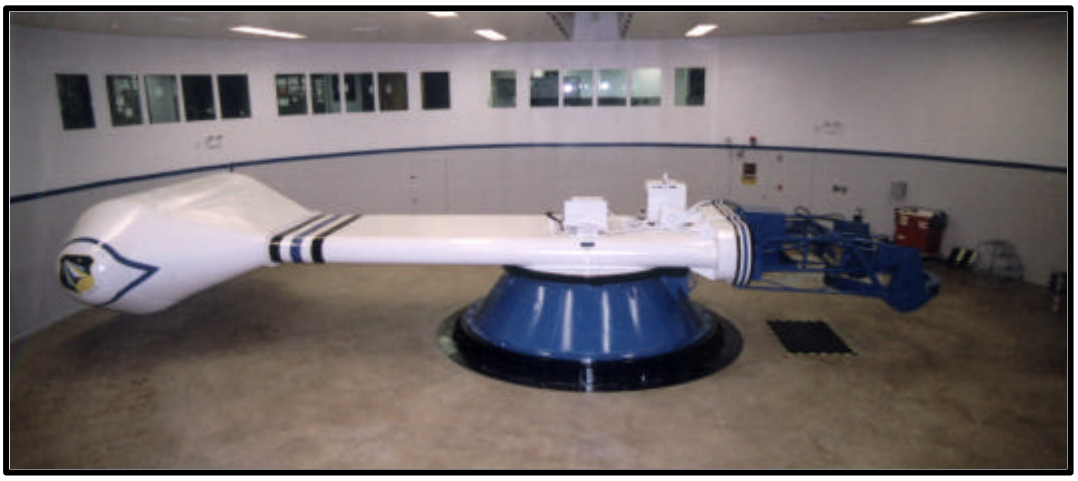
SBIR Phase II:Integrated Aircrew Ensemble (IAE). Paul Werchan, Ph.D., AFRL/HEPG, Al Gonzalez, HSW/YAS. Currently, aircrew members are faced with donning multi-layers of equipment causing heat stress and reduced mobility. As equipment items are often developed to mitigate specific threats or provide a performance capability, multiple configurations of equipment ensembles exist, each specific to a given mission and level of protection. The current environment requires a multitude of protection capability from Nuclear Biological and Chemical to Fire, heat, smoke, and cold dry/wet exposure hazards. Flight gear must also provide G-loss of Consciousness (GLOC) protection for high performance aircraft and integration with oxygen delivery, escape and bladder relief systems. Further research is needed to analyze and develop concepts/solutions to an integrated ensemble that reduces bulk and thermal stress giving required aircrew protection, performance, and mobility. Consideration should be given to incorporating lightweight breathable materials and/or fewer material/garment layers, thus reducing bulk and weight. Advances in this area may require a paradigm shift away from traditional pneumatic bladders, and towards the use of "active/smart materials".

Status: Phase I SBIR was completed last year and the same company (TIAX, LLC, Cambridge MA.) was selected for a SBIR Phase II. Phase I resulted in a new concept (proprietary) design for an IAE. The result of the two year effort will be the delivery of a working prototype of the IAE design.

SBIR Phase II: Personal Heat Pump. Wayne Isdahl M.S., AFRL/HEPG, Richard Roussett, HSW/YAS. The goal is to provide a system to reduce the heat stress experienced by flight-line maintenance and aircrew personnel. The system needs to be compatible with mission environments and existing personnel equipment worn/used by flight-line maintainers and aircrew, to include NBC protective gear. This system may prove beneficial to firefighters and other emergency response personnel.

SBIR Phase II: Urine Collection Devices. Maj Robert O'Connor, AFRL/HEPG, Omni Measurement Systems, Inc (OMS), located in Burlington, Vermont, is in the second year of a two-year contract to develop a female aircrew urine collection device. The contract is funded by the USAF's Small Business Innovative Research (SBIR) program, and is a Phase II SBIR effort. OMS is also working to develop an improved urine collection device for male aircrew. The OMS approach for both the female and male devices includes a disposable unit worn by the aircrew during flight, a pump to help remove urine from the disposable unit during urination, and a urine collection bag that attaches to the pump. The pump and collection bag are stored during flight until needed. The female disposable unit is a thin inflatable pad which is inflated prior to urination to form a collection area and to produce a seal. The male disposable unit resembles a soft protective sports cup, and is also inflated prior to use. Both the female and male units are easily deflated after use. OMS conducted in-house trials of the female and male devices with volunteer human subjects. Simulator evaluations by aircrew occurred in 2004 and a flight trial will be pursued for 2005.

Brooks City-Base Centrifuge Refurbished. Paul Werchan PhD, AFRL/HEPG, Wayne Isdahl M.S., AFRL/HEPG, Nathan Dillon, General Dynamics. A three week refurbishing project was just completed on the Brooks City-Base Centrifuge. This included a fresh coat of paint with a modern color scheme for the centrifuge, centrifuge room, control room and adjoining room. In addition to painting, the video and computer monitors in the console were replaced with 19 inch rack mount LCD displays. The X-Y plotter and subject data tracking computer functions were merged into a single computer for displaying centrifuge acceleration profiles and tracking subject data on a single LCD display. Three 32 inch LCD monitors were added to the control room and two cameras were added to the centrifuge pit to improve situational awareness and safety of centrifuge operations. The upgrades have not only given the centrifuge a cleaner, sleeker appearance, it has helped to improve operational flexibility and efficiency.



Acceleration activities update from the US Naval Air Systems Command Patuxent River, Maryland

Barry S. Shender, Ph.D

1. NAVAIR's focus the past year has been on the further development and testing of the Tactical Aircrew Integrated Life Support System (TAILSS), funded by the Office of Naval Research. TAILSS provides enhanced adaptive G-protection with PBG that is less encumbering and cooler than current COMBAT EDGE ensembles. TAILSS features an extended coverage five-bladder trouser similar in appearance to the chaps-style standard CSU-13B/P. The ensemble also has a ventilated counter-pressure vest with a wicking vapor permeable liner. Adaptive biofeedback anti-G pressurization control is provided by real-time monitoring of ECG, EMG, temperature, humidity, SpO2, head level pulse, and cerebral oxygenation (near infrared spectroscopy).
2. In the past year new textiles and anti-G suit bladder concepts were developed. These included removable bladders and an attempt to restrict inflation distention of the thighs and calves by (a) using a lighter weight Nomex for the inner layer, (b) a new type of filament Nomex for the outer shell, and (c) a new type of bladder utilizing a series channels instead of a single open cell. The latter was done to reduce trouser bulk and interference with cockpit controls when inflated. Compared to the 13B/P, inflated (10 psi using a 50^{th} percentile aerospace manikin) circumference of the channel bladders was about 20% less over the thighs and over 50% less over the calves and the diameter of the channel bladders was up to 48% less on the thighs and over 70% less over the calves.
3. A new cooling system has been developed using thermoelectric elements for air cooling for aircrew and ground personnel. The portable version weighs less than 3.5 lb (1.6 kg) and operates for 3 hr using a standard MIL SPEC rechargeable battery. The air is chilled to 10°C lower than ambient. Since it is a thermoelectric based system, heated air can also be provided at the touch of a button.
4. Two major trials were performed on the system this past year. The first was a flight demonstration in which two test pilots (former USN and USAF) each completed four flights for a total of eight one-hour F/A-18B sorties at NASA Dryden Flight Research Center from June-Aug 2004. The ability of the system to collect biophysical signals, provide G-protection, and air cooling was reported at the AsMA meeting earlier this week.
5. The second trial included a centrifuge evaluation at Brooks City-Base of the TAILSS system featuring a wireless interface between the subjects and control computer in Jan-Feb 2005. Data were collected on nine subjects (three females and six males). The evaluation included the different anti-G suit concepts and biofeedback control. Cognitive performance was assessed during the exposure with a dichotic listening (DL) task and, immediately after the +Gz exposure, subjects continued the DL task along with a short term spatial memory task for 90s. In addition, a portion of each centrifuge insertion included a series of unprotected runs in which A-LOC was deliberately induced. A total of 24 A-LOC and 16 G-LOC episodes occurred. Data analysis is underway and will be reported at the 2006 meeting. Initial subjective responses indicated that the subjects felt that wearing the TAILSS trousers helped to mitigate physical fatigue, reduce light loss, and they had to work less than when wearing CSU-13B/P.
6. NAVAIR's efforts in spinal injury protection continued with the further development of an anatomically based parameterized probabilistic spinal injury prediction model. The neck portion of the model should be completed by next year. There is also an effort to modify the racing car Head and Neck Support (HANS) device for use in tactical and helicopter platforms. A preliminary design was completed and form fit studies carried out in an F/A-18 cockpit simulator. Updates on these efforts were provided at an AsMA panel presentation this past Monday.

NASA Short Radius Centrifuge

Larry Meeker

Wyle Laboratories has recently completed the development and installation of a short radius centrifuge for NASA to be used in researching the effects of artificial gravity (AG) as a potential countermeasure to the negative effects of microgravity on the human body. The system has recently completed Low G (up to one G_R at the feet) human testing and is preparing to undergo High G human testing (up to 5 G_R at the feet).

The short radius centrifuge is installed at the University of Texas Medical Branch (UTMB) at Galveston in close proximity to UTMB's existing Bed Rest Facility. Developed as a research tool, the short radius centrifuge has two 3m arms that can support two subjects, producing a maximum acceleration of 5G at the feet. The location of the subject on the centrifuge was designed to be adjustable to support scientific testing. The SRC, as shown, consists of two primary elements, the Base Centrifuge Assembly and two Subject Station/Footplate Assemblies. The Base Centrifuge Assembly houses the SRC rotating and driving mechanisms while the Subject Station Assembly/Footplate Assembly portion supports the human test subject and contains the medical monitoring hardware required to conduct the investigation.

The Base Centrifuge Assembly primary components are the base and hub assembly, arm assemblies and motor control system. The base and hub assembly includes the drive motor, nominal and emergency braking mechanisms, arm assemblies attachment structure, and slip ring assembly for transferring power, commands and data through the hub. The arm assemblies are adjustable from 0 (flat) to 6 degrees to maintain the head down subject position. Each arm assembly contains a data collection system and an interconnect panel. The motor control system includes the operator console, motor drive and safety interlock system.

The Subject Station/Footplate Assembly includes a force plate for human test subject load measurement, a 3-axis accelerometer, video camera and monitor, data collection system, medical sensors and instrumentation. This assembly also contains a human test subject actuated call switch, restraint harness, air deflection shield and intercom system.

The research to be performed as part of the AG Project addresses some of the physiological problems associated with long-duration space flight, including loss of muscle and bone mass. Such problems must be overcome if NASA is to mount a successful mission to Mars.

This research is being conducted under Wyle's 10-year Bioastronautics Contract, which allows the company to provide life sciences research as well as special-use systems and services for NASA's manned space program.

The short radius centrifuge will be utilized during the AG Project in two phases. The first phase supports the AG Pilot Study, and the second phase will integrate additional physiologic monitoring hardware and exercise countermeasure equipment to support an International Multidisciplinary Artificial Gravity (IMAG) study with NASA research partners in Germany and Russia.

The AG Pilot Study will expose test subjects to daily one-hour doses of 2.5G at the feet as a countermeasure to the deconditioning stimulus of 3 weeks of head-down bed rest. Bed rest has been shown to produce many of the same physiological effects observed in astronauts after long-duration space flight missions. A group of researchers from NASA and several universities will take measurements of bone, muscle, cardiovascular, immune, and neurological systems immediately before and after the bed-rest period. These data will be compared with a control group of subjects not receiving the AG countermeasure. Investigators predict that the passive acceleration treatment on the centrifuge will protect the health of test subjects during bed rest and may also be useful during future space missions.

During the IMAG phase of this study, subjects will be exposed to similar AG treatments while simultaneously performing some type of exercise regimen such as cycling. In addition to the US study, researchers from Russia and Germany will also investigate various aspects of AG on identical centrifuges as part of the IMAG project. This combined effort will help to maximize the return on data and speed the arrival of an optimal AG prescription. Another benefit of this project is that multi-disciplinary teams from each nation will learn how to work with one another on complex scientific investigations.

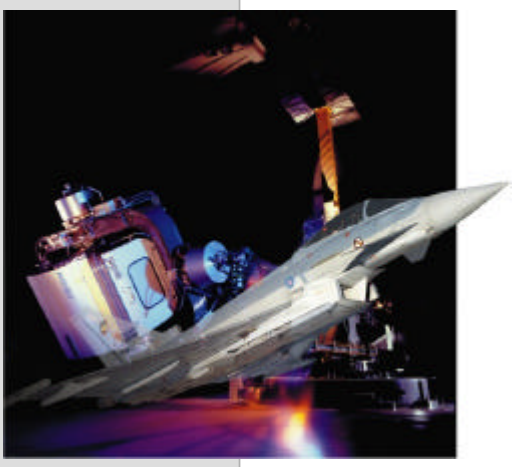
If proven effective, artificial gravity produced by a short radius centrifuge may provide a low-cost alternative to larger rotating structures, making it a countermeasure that could be implemented in the very near-term.

The Centrifuge at the Institute for Aviation Medicine of the German Air Force

Heiko Welch, MD

The Centrifuge at the Institute for Aviation Medicine of the German Air Force at Königsbrück, near Dresden

by Richard Schl üsselberger, AMST

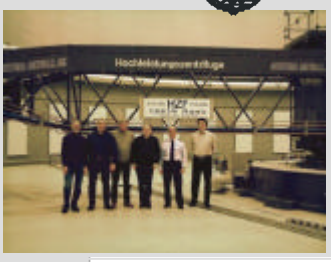


A long story of success and a view into a promising future.

The FA of the original HZF (HumanZentriFuge) was end of March 1986 (39 month after contract awarded) and was in operation until 2004. During this 19 years the HZF was performing in total **18.819 missions** without any major error and no single mission had to be shifted to another date.

Due to the Typhoon program the GAF decided to upgrade the HZF to HZF-EF2000 using the same motor, pedestal and arm and by changing the gimbals system, the control system and the control stations.

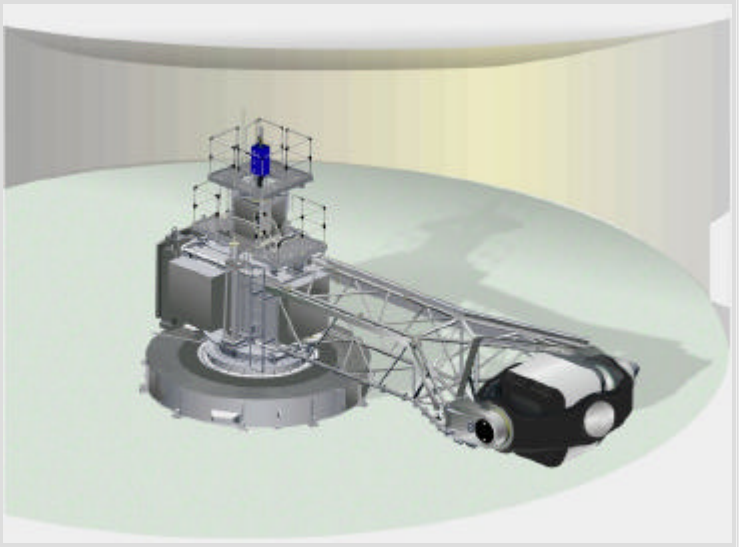
The performance will be increased to a peak onset-rate of 12,7 G/s and to max. $+15G_z/-6G_z$, $\pm 10G_x$, $\pm 6\ G_y$. The gimbal drives are special designed electrical direct drives, the roll ring and the gondola are produced of compound materials for low weight and high performance in speed and acceleration to enable the FMI to simulate the flight envelope very close to the Typhoon. The interior of the gondola look like the Typhoon, the DFS system will simulate a training aircraft and the Typhoon in cooperation with EADS. The HZF-EF2000 will be fully operational by end of 2005.



Parallel to the upgrade program of the HZF the Simulation Centre at Königsbrück was also refurbished. We got a new control room, medical preparation- and resuscitation room, a new power supply and air conditioning system for the building. The centrifuge hall will be refurbished and will get a new design by painting with nice and bright colours.

Most of the program on FMI side was specified and managed by Steffen Zöllner in cooperation with Col. Dr. Heiko Welsch. It took us all by surprise when Steffen Zöllner passed away by end of last year.

Author: Richard Sollhuselberger
CEO AMST-Systemtechnik
5282 Ranshofen, Austria



Acceleration Research Report from the Swedish Defence Research Agency

Acceleration Physiology

Ola Eiken

Research projects concerning acceleration physiology and spatial disorientation have been undertaken both at the Dynamic Flight Simulator (DFS) and at the centrifuge at the Karolinska Institute. Projects/problems that have been dealt with during the past year are:

• G-tolerance and G-comfort
- Effects of the counter-pressure jerkin during pressure breathing at high G-loads.
- Interaction between different G-protective measures i.e. AGSM, extended coverage anti-G suit and PBG (see Eiken et al., abstract 122)
- Pulmonary gas distribution at increased G-load as influenced by the different components of the anti-G-suit (see Grönkvist et al., abstract 242)
- Pressure habituation of arm veins – relation to G-induced arm pain (see Kolegard et al., abstract 241)
- G-tolerance as influenced by the distensibility of the blood vessels in the legs.
- Release of vasoactive substances at high G-loads.
- Physiological effects of long duration fighter aircraft missions.

• Spatial disorientation and motion sickness
- Spatial orientation studied via measurement of the subjective horizontal during complex vestibular stimulation.
- Effects of motion sickness on autonomic functions (see Nobel et al., abstract 391)

Man Systems Interaction

Britta Levin

A study investigating the effects of G-exposure on memory performance is completed. The study is based on a word recognition test used to investigate the ability to encode new words and recognize old word when exposed to accelerations near the passive g-tolerance level.

The validation of the DFS is continuing. Test series one comprising evaluation of pilot in control target chase and selected maneuvers is completed.
Test series two, which started in the spring, is intended to evaluate the effects of visual displays on suppressing the unwanted sensations during onsets to and offsets from high G-levels such as 9G.

An ongoing TNO Human Factors cooperation concerns a study of tactile indication of threats/targets by means of a TNO Tactile Torso Display in the DFS. This study includes flight simulations and maneuvering with the Gripen fighter aircraft system during increased G-loads up to around 8-9 G and with fighter pilots as subjects.

Swedish Air Force Report

Jonas Wikman
Acting Commander of the Aeromedical Center

During the past year the Aeromedical Centre in Linköping has successfully conducted screening, training and qualification of air force pilots in the Dynamic Flight Simulator.

Fighter pilots from Sweden, Germany, Finland, South Africa, Hungary, Czech Republic, among others have trained and qualified, with a success rate of 100%.

The training and qualifying consists of flight simulation (Gripen 39) in combination with pilot controlled or standardized high G profiles.

NEWS from AMST

Wolfgang Lindlbauer

The successful Site Acceptance Test for the Chinese HTC/DFS and recent orders for 2 new Human Centrifuges give us great pleasure and satisfaction. Importantly, these developments clearly show the reliability and leadership of AMST in providing complete aeromedical solutions for our customers.

Beijing – Institute of Aviation Medicine - BIAM

The Site Acceptance Test for the BIAM - HTC/DFS has been performed successfully. All contractually agreed performance parameters and functions have been completely fulfilled.

Indian Air Force – Institute of Aviation Medicine – Bangalore

The contract for the delivery of a High Performance Human Centrifuge – HPHC has been awarded to AMST. Contract signature occurred in March 2005. The contract includes a HPHC for training & research, an associated building and an independent power supply.

Russia

In January 2005, AMST has signed a contract for the supply of a new HTC/DFS.

Environmental Tectonics Corporation (ETC)

Dick Leland
Vice President, Aircrew Training Systems

Due to significant interest both in the USA and internationally, Environmental Tectonics (ETC) has begun production of the ATFS-400 II, the next generation Authentic Tactical Flight Simulator. Production of the ATFS-400 II follows successful completion of a comprehensive Factory Acceptance Testing process, involving customer experts, that was conducted at ETC's main manufacturing plant for the G-FET II / ATFS-400. This G-FET II / ATFS-400 is now being installed at the customer's site and will begin training pilots this year.

The ATFS-400 II builds on previous ATFS technology to provide fighter pilots with an even higher fidelity and more realistic ground based training experience.
Over the past twelve years, ETC has developed and manufactured the G-FET II; a project that has produced the world's most advanced high performance human centrifuge. Over the past five years, ETC has integrated full Tactical Flight Simulation into the G-FET II to produce the G-FET II / ATFS-400. The G-FET II / ATFS-400 combined the latest available flight simulation technology to optimize flight fidelity. This technology includes high fidelity aircraft specific cockpits, offensive and defensive mission systems, realistic wide field of view visual displays, virtual battle space and ETC's proprietary G-pointing technology. The ATFS-400 II represents cutting edge technology that provides the pilot with the same sustained Gs that he/she experiences during actual combat maneuvering for the most authentic experience possible short of flying the aircraft.

The ATFS technology was put to the ultimate test during ETC's Orange Flag event in February 2004. During this event more than 70 highly experienced fighter pilots from 10 different countries came and flew the G-FET II / ATFS-400. The response was overwhelmingly positive. As one experienced pilot said, "The technology works. Now it is time to put it to work."

Worldwide Human Centrifuge Status
Institute of Aviation Medicine
Australia

Dr. Bhupi Singh

	Canada DRDC Toronto, ON	USA (USN) (NAWC), PA	USA (USN) AS Lemoore, CA	USA (SUNY), Buffalo, NY	USA (USAF) AFRL Brooks CB San Antonio	USA (USAF) Holloman AFB, NM	USA (USAF) WP AFB, Dayton, OH
Commissioned	**?**	**1952 (1964)**	**1996**	**?**	**1962 (1984)**	**1988**	**1969**
Operational Status	**Under refit**	**Mothballed**	**Full**	**Full**	**Full**	**Full**	**Full**
Training/ Research	**Research, Training**	**Research, Training**	**Training**	**Research**	**Research, Training**	**Training**	**Research**
Arm length	**6.1m (20ft)**	**15.2m (50ft)**	**7.62 metre**	**?**	**6.1 metres**	**6.1 metres**	**5.8 metres**
Maximum G	**+15G**	**+40G**	**+15G**	**?**	**+30G**	**+15G**	**+20G**
Peak G Onset Rate	**3G/sec**	**10G/sec**	**8.5G/sec**	**1G/sec**	**6G/sec**	**6G/sec**	**1G/sec**
<1G Capability	**No**	**Yes**	**No**	**No**	**No**	**No**	**Yes**
Builder	**EMRO, DRDC**	**McKiernan -Terry**	**ETC**	**In house**	**Rucker**	**ETC**	**Franklin Inst.**
Availability	**Pending**	**Pending**	**Training**	**Open**	**Open**	**Limited**	**Open**
Gondola control	**?**	**Active**	**Active**	**Passive**	**Passive**	**Passive**	**Active**
Remarks				**Altitude capable gondola**		**Replacement under consideration at Luke AFB**	**Dynamic Environment Simulation**

	UK (RAF CAM) Henlow	UK (Qinetiq) Farnborough	France, Bretigny	Holland, Soesterberg	Germany, Konigsbruck	Poland, Inst Av Med	Sweden, Linkoping
Commissioned	**-**	**1955**	**1999**	**1983**	**1986**	**?**	**2003**
Operational Status	**TBD**	**Full**	**Full**	**Full**	**Closed, under refit**	**Full**	**Full**
Training/ Research	**Research, Training**	**Research, Training**	**Research, Training**	**Research, Training**	**Research, Training**	**Research, Trg**	**Research, Training**
Arm length	**TBD**	**9.14m (30ft)**	**8 metre**	**4 metres**	**10 metres**	**9.0 metres**	**9.14 metres**
Maximum G	**+15G**	**+12G**	**+30G**	**+23.5G**	**+12G**	**+16G/-2.5G**	**+15G**
Peak G Onset Rate	**10G/sec**	**1G/sec**	**10G/sec**	**3.5G/sec**	**5G/sec**	**4G/sec**	**10/sec**
<1G Capability	**Yes**	**No**	**Yes, -10 G**	**No**	**Yes**	**Yes**	**No**
Builder	**TBA**	**ML Aviation**	**Latecoere**	**HOLEC Co**	**AMST**	**Polskie ZL Co**	**Wyle**
Availability	**Open**	**Open**	**Open**	**Open**	**Limited**	**Open**	**Open**
Gondola control	**Active**	**Passive**	**Active**	**Passive**	**Active**	**Active**	**Active**
Remarks	**Under review for cancellation**	**Scheduled to close 2006-2008**			**Being upgraded**		**Dynamic Flight Simulator**

	Sweden, Karolinska	Japan	Singapore	Turkey	Taiwan	Russia, Zhukovsky	NASA AMES Moffett Field, CA
Commissioned	**1955**	**1999**	**1994**	**1990**	**?**	**2002**	**1966**
Operational Status	**Full**	**Full**	**Full**	**Full**	**?**	**Full**	**Full**
Training/ Research	**Research, Training**	**Research, Training**	**Training**	**Training**	**Training**	**Research**	**Research**
Arm length	**7.25 metres**	**7.6 metres**	**7.62 metres**	**6.1 metres**	**8 metres**	**8 metres**	**8.84 metres**
Maximum G	**+15G**	**+12G**	**+15G**	**+15G**	**?**	**+15G**	**+20G**
Peak G Onset Rate	**5G/sec**	**6G/sec**	**8G/sec**	**6G/sec**	**?**	**9G/sec**	**1G/sec**
<1G Capability	**Yes, U/S at present**	**No**	**No**	**No**	**?**	**Yes**	**No**
Builder	**ASEA Sweden**	**ETC**	**ETC**	**ETC**	**Latecoere**	**AMST**	**In house**
Availability	**Open**	**No, unless approved**	**Open**	**Open**	**Open**	**Open**	**Open**
Gondola control	**Passive**	**Active**	**Active**	**Passive**	**?**	**Active**	**Passive**
Remarks	**Upgraded in 97**					**A monster!**	

	India, IAF IAM Bangalore	South Korea	Malaysia	China, Beijing	Egypt	Nigeria
Commissioned	**?**	**1990**	**-**	**-**	**1995**	**?**
Operational Status	**Full**	**Full**	**Being installed**	**Being installed**	**Full**	**?**
Training/ Research	**Research, Training**	**Research, Training**	**Training**	**Research, Training**	**Training**	**Training**
Arm length	**5.0 metres**	**6.1 metres**	**7.62 metres**	**7.62 metres**	**7.4 metres**	**6.1 metres?**
Maximum G	**+10G**	**+15G**	**+15G**	**+15G**	**+15G**	**+15G?**
Peak G Onset Rate	**2G/sec**	**6G/sec**	**10G/sec 13G/sec max instantaneous**	**10G/sec**	**6G/sec**	**6G/sec?**
<1G Capability	**No**	**No**	**Yes**	**?**	**No**	**No**
Builder	**Siemens**	**ETC**	**ETC**	**AMST**	**Krug/ETC**	**ETC**
Availability	**Indian military aircrew only**	**?**	**?**	**?**	**?**	**?**
Gondola control	**Passive**	**Passive**	**Active**	**Active**	**Passive**	**Passive**
Remarks	**Possibly to be upgraded**		**Expected commissioning in 2004**	**Expected commissioning in 2004**		


Records & Firsts
• Maj Gen Harry G Armstrong – First human centrifuge in North America (May 1935)
• Dr. Michael McCally – First to ride the DES at Wright-Patterson AFB (19 December 1969)
• Dr. Dana B. Rogers – First Closed Loop (December 1970)
• Dr. Cady Coleman – Longest SACM (4.5 to 7 G for 17 minutes)
First subject to become an astronaut
• Dr. Ben Kallner – Oldest centrifuge rider (64 years old, 7 G)
• Chuck Dempsey – Rode the One Millionth Revolution of the DES (18 September 1983)
• Dr. Cady Coleman – Rode the Two Millionth Revolution of the DES (25 March 1994)
• Col Rick Allnutt, Dr Dana Rogers, John Frazier, Lloyd Tripp, Dr Bill Albery, Marvin Roark, MSgt Tim Robinson, and Lt Col Mark Sheehan all rode portions of the Three Millionth Revolution of the DES (7 September 2004)
Most Rides on the DES (as of 21 April 2005)
Lloyd Tripp (261)
Col Richard Allnutt (202)
MSgt Sharon Willis (193)
Lt Col Bob Bennington (192)
SSgt Rick Hutton (152)
Capt George Valentino (135)
Capt Kathy Tyson (112)
Capt Kelley Greene (111)
SSgt T.C. Cartwright (111)
Major Steve Popper (102)
Lt Chris Snyder (102)
Capt Jeff White (100)
Highest G Level
16.5 Gx
(December 1958 – January 1959)
John Frazier
Neville Clarke
Bill Elkins
Larry Berman
Gene Schumpert
Longest G Exposures
3 Gz for 1 hour
(October 1957 – March 1958)
John Frazier
Lt Dick Geer
Lt Frank Moore
A1C Bill Jones
Capt Hugh Miller, M.D.
A1C Dick Heath
Capt Stuart Bondurant, M.D.
Lt Brown Riley