The +$G_z$ette

Submissions from the International Acceleration Research Workshop Community

Volume 3, Issue 1 May 2003

Inside This Issue

Where and When

This is the 16th 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 San Antonio, Texas.

The workshop will take place at:

Room: 002, Convention Center
Thursday, 8 May 2003
12:15 – 14:00

This year's International Acceleration Research Workshop is generously sponsored by:

wyle laboratories

Chairman of IARW 2003

and Editor of +$G_z$ette:

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Thursday May 8, 2003;
12:15 – 2:00 PM

Room: 002, Convention Center
San Antonio, Texas

2003 International Acceleration Research Workshop

Agenda

- **Welcome**
- **Introductions**
- **Special Announcements**
  (safety related events, requests for information)
- **Discussion of newsletter articles and/or Laboratory/National Reports**
- **Other presentations or discussions of acceleration research related topics**
- **Chair selection 2004**

Acceleration Research in India

The Indian Society of Aerospace Medicine formed in 1954 with the objective of promoting the science and art of Aerospace Medicine, lateral interactions with Aviation disciplines and to promote and maintain safe mission establishment. The advnt of aircraft capable of sustaining high +Gz necessitated the procurement of the Human Centrifuge. Dr Ing Rolfe Schroeder designed it in Germany and it was commissioned at the Institute of Aerospace Medicine, Bangalore in 1966.

The centrifuge is capable of delivering a multi-segmented G profile with maximum onset/ offset rates of 0.1 to 2G per second and a peak of 10G. There is a multi-channel micro-controller based digital data acquisition and retrieval system with complete optical isolation. This is utilized for real time physiological and physical data monitoring. Two way audio and 2 channels of video monitoring exist.

The Human Centrifuge has been employed for diverse purposes including: -

Training of aircrew

Evaluation of aircrew protective assemblies and systems

Simulating +Gz stress for aircrew fitness evaluation

Basic research

Spatial Disorientation training

The faculty of Acceleration Physiology at IAM has been involved in conducting research. The following are few of the topics that have been studied at the Institute's faculty:

LBNP & G Tolerance

(b) Effect of +Gz on vision with contact lenses

(c) Effect of Physical conditioning on G tolerance

(d) Urinary stress parameters in G stress

(e) Correlation of Anthropometry & HR with G tolerance

Comparison of L1, M1, Q-G & Hook manoeuvres

ECG changes in High +Gz stress

Comparison of PBG and AGSM

Comparison of anti-G suits

The Department conducts two courses for fighter aircrew of 2 day and 2 week duration. The first is directed at aircrew before their exposure to the fighter trainer aircraft and the second one is a more exhaustive course for aircrew likely to fly the ASFs. Indoctrination of transport and helicopter aircrew is also conducted.

The IAF aircrew training is poised for a sea change with new state of the art Centrifuge and Spatial disorientation simulators likely to be acquired in the near future. It shall be a force multiplier and help in achieving the objective of the Indian Air Force- "Touch the sky with Glory".

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Acceleration Research Report from the Swedish Defence Research Agency.

It appears that the Dynamic Flight Simulator in Linkoping will be operational within this year.

Presently, all Acceleration research projects are undertaken in the centrifuge at Karolinska Instutet, Stockholm. Completed or on-going projects/questions during the past year can be listed as follows:

• G-induced arm pain

- **Acute and long-term effects of increased and decreased pressure in arm vessels**

• Pulmonary function at increased G-loads

- **Effects of increased G-load and anti-G suits on pulmonary gas distribution**
- **Effects of counter-pressure jerkin during pressure breathing at high G-loads**

• G-tolerance

- **Physical fitness and G-tolerance**
- **G-tolerance as affected by the distensibility of the blood vessels in the legs**
- **Interaction between different Gprotective measures (i.e. AGSM, extended coverage Anti-G suit and PBG)**

• Spatial disorientation and motion illness

- **Vestibular mechanisms involved in the development of "the leans" and "G-excess" illusions**
- **Effects of motion sickness on autonomic functions**

Stockholm March 12, 2003

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Latest News from the Human Centrifuge, Koenigsbrueck, Germany

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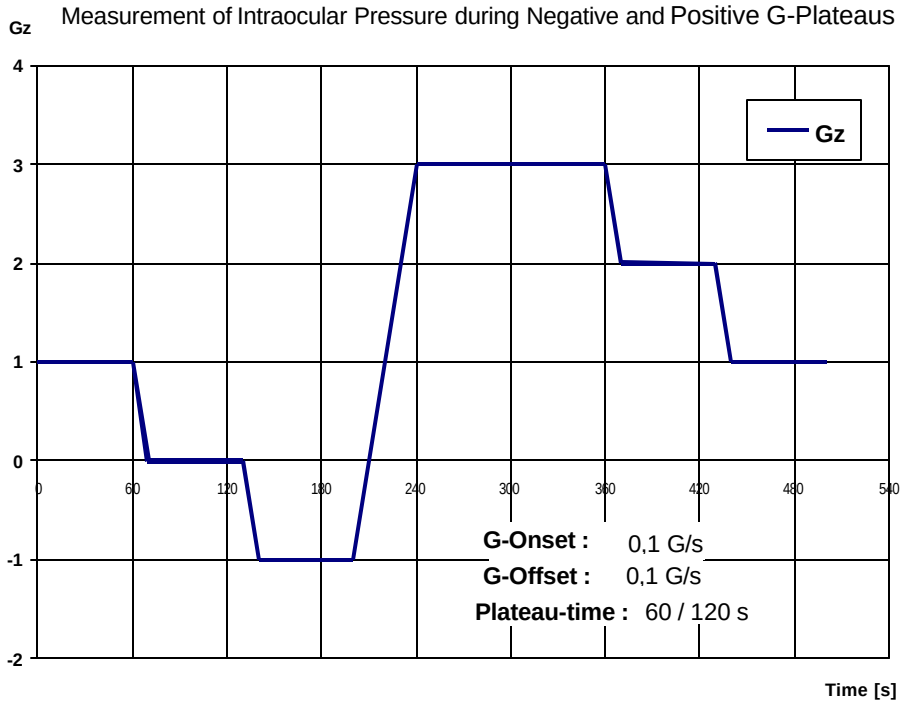
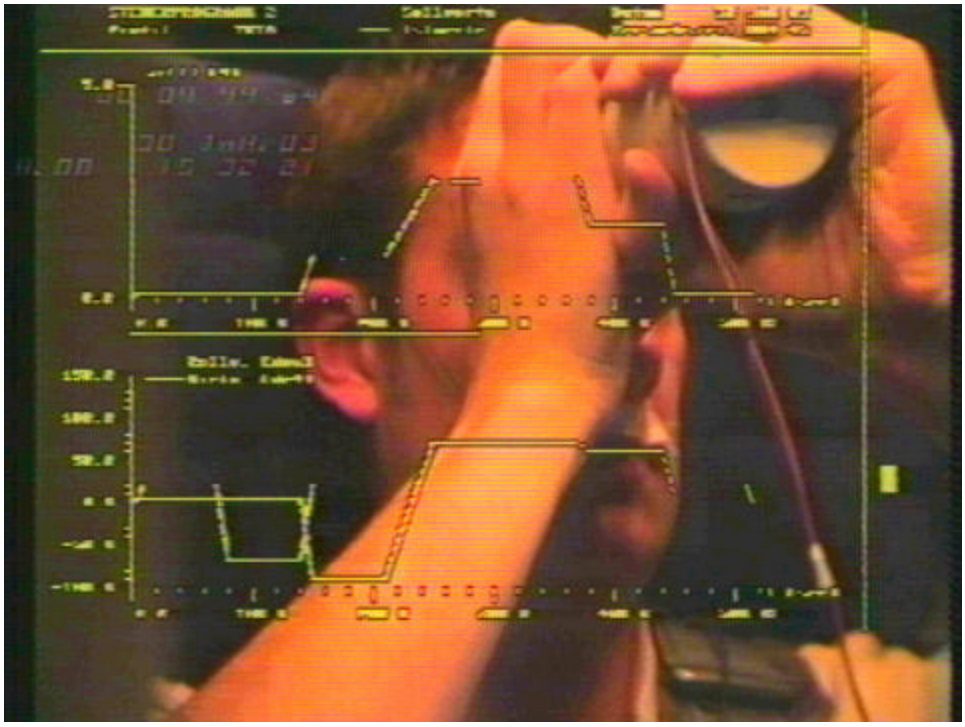
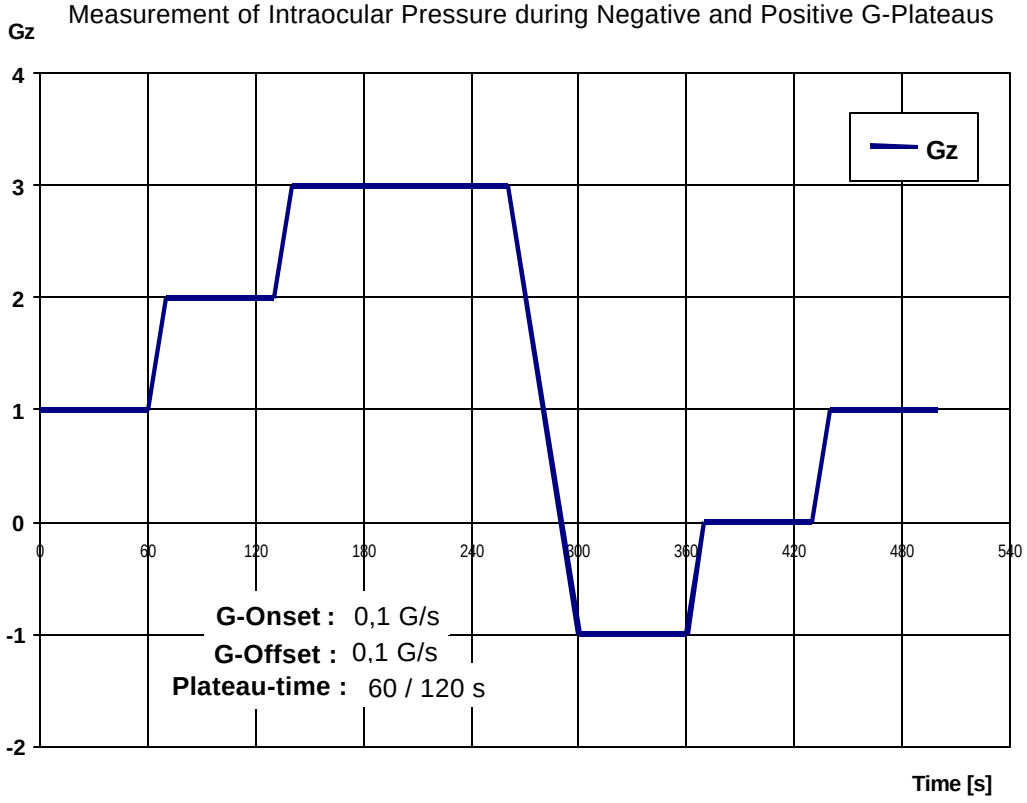
1. Self-Tonometry in the Human Centrifuge

Measuring the intraocular pressure in the human centrifuge with a tonometer by the subjects meter by the subjects themselves with two different profiles including negative Gs in January 2003 – a successful experiment in co-operation with the University of Hamburg (Professor Dr. Draeger) and Lufthansa Airline pilots.





Measurement of Intraocular Pressure during Negative and Positive G-Plateaus



Self-Tonometry in the Human Centrifuge with different Positive and Negative G-loads

Results will be presented by the subjects themselves.

Impressive: The handling of the tonometer even under the conditions in a human centrifuge and the necessity of a smooth ride during the measure periods.

2. "LIBELLE G-Multiplus"-Familiarisation Program for USAF-Test Pilots

January 2003: 2 USAF test pilots and 2 test engineers from the 28 Test Squadron/TEH Eglin AFB, FL were successfully trained in the special technique to use the "Libelle"-suit under correct conditions to optimise the G-protection function. A new "+9G-endurance-record" was established: +9gz for 75 seconds.

3. High G Training for German Air Force Eurofighter/Typhoon Pilots:

April 2003: 12 GAF operational pilots from different wings and extended flight-experience on GAF and USAF-fighter and fighter-bomber aircraft succeeded in the first 3 new special training courses for high agile aircraft in the centrifuge in Koenigsbrueck.

Integrated in this training is the familiarisation program with the "Libelle"-suit (the official AEA for the Typhoon is not qualified yet) and active training with the human centrifuge in the pilot-in-control mode and the interactive-steering mode. High G-onset runs and push-pull manoeuvres were integrated tasks during the operational training.

15th April: The "+9G-endurance-record" was recaptured by the GAF commander of the MiG 29 fighter wing himself and stands now at +9gz for 85 seconds.

Dr. H. Welsch, Col. M.C.

Head of Division Aviation Physiology, German Air Force Institute of Aviation Medicine

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Activities at Air Force Research Laboratory at Wright Patterson Air Force Base, Ohio, USA

AFRL/HEPA Wright-Patterson AFB OH
May 2002-April 2003

1. **Joint USAF-Navy research study on the effects of G-Layoff on pilot G tolerance completed: The Naval Aerospace Research Laboratory (NAMRL), Pensacola FL sponsored sustained acceleration research on the AFRL Dynamic Environment Simulator (DES) centrifuge at Wright-Patterson AFB over the past year. NAMRL was interested in the effect of pilot lay-off from high-sustained acceleration (G) on pilot G tolerance. The question that was raised was "If a high-performance aircraft pilot does not fly for 1 or 2 weeks, and is not exposed to high G, is there a decrement in performance or G tolerance? If so, how soon do the changes occur? Do any changes occur in two weeks or as early as one week after layoff?" Since the Navy has closed its acceleration research facility at Warminster PA, they no longer have the means to study this question. Eleven subjects participated in training followed by one and two week lay-offs. Some physiological monitoring was accomplished utilizing a device provided by the Navy. The COSMED K4 b^2 physiological monitor is a small, self-contained unit that fits on a harness allowing unrestricted subject movement. An oxygen sensor in this unit samples exhaled air and allows calculation of oxygen consumption during exertion. A delicate turbine in a mask detects ventilation. The Navy suggested adding the COSMED to the layoff experiment to**

discover what physiological changes might occur during training and subsequent layoff periods. Data are now being evaluated with assistance from Naval investigators to determine pulmonary gas exchange parameters including oxygen uptake, CO_2 production, and respiratory frequency. It also allows calculated indirect calorimetry providing indications of energy expenditure. Preliminary results show significant reductions of G tolerance with both a 7-day and 14-day layoff. These results indicate that subjects were unable to endure exposure to a 4 to 7 ½ G simulated aerial combat maneuver as long after layoff as they could prior to the layoff. Final results detailing oximetry, blood lactate, and tracking performance should be reported at this meeting.

2. **GLOC Phase II data analysis completed: The data from the reduced recovery acceleration levels phase of the USAF-Navy G induced loss of consciousness program have been analyzed. The purpose of this phase of research was to determine if a pilot recovered from a GLOC sooner if he/she was able to recover from the GLOC at less than +1 Gz. This would mean the GLOC would have to be detected and that the aircraft could be rolled over 180 degrees or decelerated to produce the less than 1 Gz environment. The premise is the reduced gravity would enhance blood volume return to the head, thus increasing eye level blood pressure and brain function. Phase I results showed that subjects did not recover sooner as a function of the number of exposures to GLOC. The total recovery period was no different after the fourth GLOC compared to the first. In this Phase II research, subjects were exposed to –1 Gz, -0.5 Gz, or + 1 Gz subsequent to GLOC. The post-GLOC recovery data indicated a trend toward reduced relative incapacitation recovery time for profiles less than +1 Gz compared to the +1 Gz recovery G-exposure, however, these data were not statistically significant. There was no significant reduction in recovery time for the absolute or total incapacitation times. Both the tracking and math tasks performed during the GLOC exposure were halted prior to the actual GLOC event. Subjects stopped performing the math task for a significantly longer period of time compared to the tracking task. Fine motor control of the tracking task was degraded for approximately 34 sec following the GLOC event. Cognitive function, as measured using an arithmetic task, was impaired for 50 seconds following the GLOC episode. These two findings are new and pose serious implications for those pilots whom GLOC, then recover and have to maneuver their aircraft immediately after their recovery. GLOC research continues at Brooks AFB, where a fourth GLOC study will end soon. Mr. Lloyd Tripp was the principal investigator on the GLOC efforts within AFRL/HEP.**

3. **Libelle (SAGE) panel at SAFE 2002: Dr Albery chaired a panel on the Foreign Comparative Testing of the Libelle G-suit (now called SAGE-self regulating anti-G ensemble) for the SAFE symposium in Jacksonville FL 30 Sep – 2 Oct 2002. AutoflugLibelle (Germany) gave a presentation in the panel on the latest configuration of the Libelle suit that was evaluated at Eglin AFB. Col Stef Stefanek, 85th Test and Evaluation Squadron Commander at Eglin gave a presentation on the flying experiences with the suit. The SAGE had mixed results. Only half the F-15 and F-16 pilots felt the SAGE provided adequate G protection. Dr Xavier Avula from the Univ of Missouri gave a technical presentation on a mathematical model of a fluid filled G-suit. AFRL/HEP will be evaluating the SAGE in centrifuge tests at Wright-Patterson AFB and Brooks City-Base this summer.**

4. **HEPA Gives Technical Presentations on Acceleration at AsMA: AFRL/HEPA gave several technical presentations at the 74rd annual meeting of the Aerospace Medical Association meeting in San Antonio 5-8 May. Dr Albery gave a slide presentation entitled "Controlled Flight Into Terrain (CFIT) and Ground Collision Avoidance Systems." Dr Chelette and Lloyd Tripp co-authored a presentation entitled "The Relationship Between Relative Changes in Leg Calf Blood Volume and Relaxed G-Tolerance as Measured by NIRS." Dr Chelette also presented "Lateral Accelerations of Amusement Rides Applied to a Head-Neck Model. Mr. Tripp also had a couple presentations in the N-LOC and G-LOC panel. Dr Ed Eveland co-authored a slide presentation with Lt. Tyson Brunstetter entitled "Durability of Relaxed +Gz-Tolerance and +Gz Endurance In Trained Subjects Following 7-and 14-day Layoff Periods."**

5. **Albery visits Russian Aviation Medicine and Human Factors facilities: Dr Albery joined a group of ten other scientists and engineers who visited Moscow and St. Petersburg 25 May thru 9 June 2002. The party visited the Russian Institute of Aviation Medicine, Star City, and the Institute of Biomedical Problems. Albery and Col Mikhail Khomenko (Russian Institute of Aviation Medicine) presented "Differences in Pilot Automation Philosophies in the US and Russian Air Forces' Ground- Collision Avoidance Systems" at the 7-9 Oct 2002 symposium on the Role of Humans In Intelligent and Automated Systems, Warsaw Poland. Dr Albery presented the role of GCAS (Ground Collision Avoidance System) and the Auto ACAS (Air Collision Avoidance System) in modern fighter aircraft. Col (Dr) Mikhail Khomenko, Chief Scientist of the State Scientific Research and Testing Institute of Military Medicine, presented the role of the "Pilot State Monitor," a Russian version of pilot monitoring system that is planned for the Su-27 and MiG-29 aircraft. Colonel Khomenko and the Institute director, Major General Igor Ushakov, are slated to visit AFRL later this summer or fall.**

6. **Auto Racing Simulation discussed: In following up on the Championship Auto Racing Team (CART) /Texas Motor Speedway (TMS) incident two years ago, and General Lyles' (HQ AFMC/CC) interest in supporting the racing industry, HEPA has looked into the possibility of simulating on the DES centrifuge the conditions in a race car experiencing high Gz and Gy in the turns and exposing a driver to those conditions. Trice Motor Group, represented by Mr. Doug Hill, along with Dr Henry Bock, the Indy Racing League Medical Director and Phil Casey, the Technical Director, visited the DES facility in 2002 and asked Dr Ted Knox and HEPA to develop a cost estimate to study the vestibular and Gz/Gy problems encountered this past year at the TMS. As a phase I approach to this problem, Dr Albery has suggested CART bring an experienced driver into the facility and have him experience a 'low G' simulation of the TMS in order to determine if the centrifuge simulation is representative of racing conditions in the eyes of a driver. Doug Hill visited the DES facility on 12 August 2002 and rode a "low G" simulation of the CART simulation (2 Gz + 1 Gy). He thought was simulation was very good but believed an improved visual simulation of a typical race would enhance the project. Hill has acquired a video taken from a car on the Texas track that can used to develop the visual simulation.**

7. **Dynamic Environment Simulator centrifuge cab upgrade: The Dynamic Environment Simulator cab video system has been upgraded with the addition of a 6' projection dome display for approx 180 deg x 150 deg surround video for terrain and threat detail. A 23" LCD panel has been recently installed to provide a near real size instrument panel display. An additional projector provides a HUD display super-imposed on the dome. Three 2.5GHz PCs mounted in the cab drive the simulation. The simulation software is Mantis Image Generator by CG2. The control stick, throttle and rudder pedals have been integrated with the simulation software. The picture of the display (top, left) was taken from the floor looking up into the cab with a subject seated in an ACES II facsimile seat. The DES (bottom picture) is in its 34th year of operation at Wright-Patterson AFB OH.**

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Activities at Air Force Research Laboratory at Brooks City-Base, Texas, USA

Acceleration workshop yearly Report:

Brooks City-Base (1Apr 02- 1 April 03)

This past year has been a busy one for the Brooks City-Base Centrifuge. We ran a total of 2,148 training exposures on 542 individuals (AETC PIT, AMPs, AF Cadets, APOs, AMMIMOs, 7 Level Coarse, and Med Evals). We ran an additional 2,776 research exposures for 6 different protocols using 52 different subjects. Our current research subject pool consists of 32 active subjects.

The research protocols were:

1. Near-Loss of Consciousness (NLOC): A protocol entitled "ACCELERATION-INDUCED NEAR-LOSS OF CONSCIOUSNESS" has started. EEG, EOG, AEP and ECG recordings, Portapres recordings for blood pressure, ear oximeter for oxygen saturation, and flight simulation tracking task and a verbal digitized calculation test for performance was used in different G-exposures in the human centrifuge. Data collection for phase one, which included the testing of suitable G-profiles for eliciting near-loss of consciousness in the centrifuge, has been completed. Results include seven G-profiles in a total of 58 different G-exposures with 5 subjects on 10 separate days. After careful review of the video recordings of these 58 tests, 15 borderline N-LOCs, 22 N-LOCs, and 3 G-LOCs were found; while in 18 tests no apparent adverse physiological or behavioral events were found. Analysis of physiological and performance results have begun, and a follow-on protocol approved.

2. Tailored breathing and anti-G suit pressures in relation to anthropometric data and pressurized arm sleeves and gloves for G-protection: A protocol has been written and approved by the IRB for a study to test whether or not individual of different size can benefit from the of pressure breathing during G and Gsuit inflation schedules tailored to their personal anthropometry. The effects of pressurized arm sleeves and gloves on acceleration tolerance will also be tested. The background is that tall persons with a long blood column from eye-level to heart and from heart to feet will have a lower G-tolerance compared to short persons with shorter blood columns. This study will assess the possible protective advantage conferred by individually calculating breathing and anti-G suit inflation pressures for individuals of different size, using their eye to heart and thigh to heart distance, respectively. The addition of pressurized sleeves and gloves, earlier developed and showed to substantially decrease G-induced arm pain, will also be evaluated for possible G-protection. The sleeves and gloves will be inflated on schedule calculated to support a hydrostatic column form the middle of the arm to the heart. Three different conditions will be tested in the centrifuge at Brooks AFB: a control with COMBAT EDGE and ATAGS standard pressures, tailored COMBAT EDGE and ATAGS pressure schedules, and tailored COMBAT EDGE and ATAGS pressure schedules combined with the addition of pressurized arm sleeves and gloves. The G-exposures will be gradual and rapid onset runs, and simulated aerial combat maneuver runs up to +9 Gz.

3. The G-MED Study: This study began in June 2002. Scheduled for completion in June 2003, it compares 4 "Go Pill" stimulant pharmacological agents administered to trained subjects after a minimum period of 17 hours of sustained wakefulness. Testing is performed during the circadian nadir (0200-0500 local time). +Gz tolerance, endurance, and a variety of aviation performance parameters are measured during this period. Subject performance is compared against placebo, and rested daytime performance. The drugs compared are dextroamphetamine 10 mg, modafinil 200 mg, pemoline 37.5 mg, and methylphenidate 10 mg. Side effects and impact on recovery sleep are surveyed. A secondary purpose of this study is to develop a simulator-based aviation performance assessment tool to compared performance impact and side effects of potential operational and therapeutic drugs considered for use in aviators. Performance measures from the Flight Performance Assessment (Standardized) Simulation System (FPASS) will be compared against the Automated Neuropsychiatric Assessment Metrics (ANAM). This is designed to determine whether the simpler and more aviation-relevant FPASS testing tool can match the validated ANAM battery of tests for measuring and comparing the impact of circadian desynchronosis and pharmacological agents on aviation performance. The impact of sustained wakefulness and circadian nadir on +Gz tolerance and endurance are issues addressed in this study.

4. Effects of Acceleration on corneal stability in postrefractive keratectomy (PRK) subjects: This study was conducted to investigate the effect of acceleration on the surface characteristics of the cornea of subjects who have had excimer photorefractive keratectomy (PRK) performed for myopia. This study was in direct

support of an ongoing study at the Ophthalmology Branch at Brooks AFB to investigate the clinical course and duty impact of PRK on myopic active duty USAF personnel. Volunteer subjects (male and female) were selected which met both the criteria for inclusion into the PRK study as well as meeting medical qualifications to be centrifuge subjects. Subjects were trained in the AFRL/HEP centrifuge to a goal of 15-sec plateaus of +3, +5, +7, +8, and +9G and repetitions of a +4.5 to +7 or a +5 to +9Gz simulated aerial combat maneuver (SACM). Subjects were then separated into the two different groups based on training performance. The +5 to+9 SACM group were provided with pressure breathing during G (COMBAT EDGE). On average, each subject's participation spanned approximately 27 months, including a 4- to 6-week period of preliminary centrifuge training and 6-, 12-, 24-month follow-up centrifuge assessments of the effects of acceleration on the post-PRK cornea. A standard battery of visual performance tests (VPT; visual acuity and refraction) and corneal measurements (topography and keratometry) were assessed in all subjects before and after centrifuge exposures. Also, visual acuity was tested during high-Gz peak sustained centrifuge runs. Data collection is now complete. Due to the extreme attrition rate (PCS, DNIF, retirement, etc.), baseline data was collected on 19 subjects, 6-month post on 13 subjects, 12-month post on 12 subjects, and only 2 subjects returned for the 24-month post follow-up. Data analysis indicates no adverse effects of +Gz on PRK treated eyes.

5. Joint Service Aircrew Mask (JSAM) Centrifuge Evaluation: The objective of the Joint Service Aircrew Mask (JSAM) program is to develop a respirator for individual aircrew that provides "above the shoulders" head, eye, respiratory and percutaneous protection against chemical and biological (CB) warfare agents, radiological particles, and toxic industrial materials (TIMs) as well as continuous protection against CB agent permeation. Additionally, when integrated with aircraft mounted and crew mounted breathing equipment (in aircraft so equipped), the JSAM will provide pressure breathing for G (PBG) protection during air combat maneuvering flight. Ideally, selected system components will be usable as an aircrew's everyday oxygen mask (in aircraft so equipped) for flying in peacetime or wartime environments. AFRL/HEP and NAVAIR were tasked to test the JSAM system performance during the Program Definition and Risk Reduction (PDRR) acquisition phase of the JSAM program. During PDRR, two contractors provided the Government with tactical JSAM variants for centrifuge testing. This testing was designed to determine both the mechanical performance of the mask under +Gz stress and its ability to provide sufficient airflow to enable comparable +Gz tolerance to the current COMBAT EDGE system. All centrifuge testing is now complete, all equipment has been returned to the JSAM program office, and the final report submitted.

6. +Gz Acceleration Induced Loss of Consciousness (GLOC) and the Effect of Sensory Stimulation on Reducing Recovery Time: The last of four protocols designed to identify novel ways to shorten the recovery time following deliberate GLOC of subjects in a centrifuge. This protocol focuses on the presentation of a stimulus (sound, light, or vibration) immediately following GLOC (absolute incapacitation period) on four separate days (includes one non-stimulus "control" day). The subject is trained to extinguish the stimuli as quickly as he regains consciousness, and to regain control of a combo math/tracking task that was initiated prior to the GLOC exposure. Data collection has been completed on 8 of 15 subjects that have started this protocol.

Six new protocols are in the planning or approval stage to start this following year.

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