

# REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 1993	3. REPORT TYPE AND DATES COVERED Final Report, <del>23 March - 14 April 1993</del> 1 Apr 1992 - 14 Apr 1993	
4. TITLE AND SUBTITLE Report of G-Protection Physiology Research Related to Extended Coverage G-Trousers with Pressure Breathing on Human Volunteers Under G-Loads on the Human Centrifuge at AL/CFTF, Brooks AFB, Texas			5. FUNDING NUMBERS F6170892W0465	
6. AUTHOR(S) Dr. Ulf Balldin				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Division of Aviation Medicine National Research Establishment Box 13400 S-17290 Sundbyberg, Sweden			8. PERFORMING ORGANIZATION REPORT NUMBER SPC-92-4015	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) EOARD PSC 802 BOX 14 FPO AE 09499-0200			10. SPONSORING/MONITORING AGENCY REPORT NUMBER SPC-92-4015	
11. SUPPLEMENTARY NOTES Two reports comprising the final report.				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Unlimited			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) Report of G-Protection Physiology Research Related to Extended Coverage G-Trousers with Pressure Breathing on Human Volunteers Under G-Loads on the Human Centrifuge at AL/CFTF, Brooks AFB, Texas				
14. SUBJECT TERMS			15. NUMBER OF PAGES 7	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UL	

**REPORT OF G-PROTECTION PHYSIOLOGY RESEARCH RELATED TO EXTENDED COVERAGE G-TROUSERS WITH PRESSURE BREATHING ON HUMAN VOLUNTEERS UNDER G-LOADS ON THE HUMAN CENTRIFUGE AT AL/CFTF, BROOKS AFB, TEXAS DONE BY ULF BALLDIN, M.D., PH.D. , NATIONAL DEFENCE RESEARCH ESTABLISHMENT, SWEDEN DURING THE PERIOD APRIL 1, 1992 TO APRIL 14, 1993.**

Analyses have been made of results of a former cooperative centrifuge study by USAF and Swedish Defence done at the AL/CFTF with Swedish fighter pilots as subjects. It showed that a pressure reduction to about 75% of the normally increased pressure could be done during gradual onset rate G-loads with the extended coverage anti-G trousers with assisted pressure breathing without compromising the G-tolerance. Further pressure reduction indicated a lower G-tolerance. During simulated aerial combat maneuvers the study showed a lower G-tolerance already with 75% reduction in pressure, also supported by changes in heart rate. The results are published in Aviation Space Environmental Medicine (1).

A follow up study, also with Swedish fighter pilots as subjects, showed similar results. The study also aimed at comparing the Swedish Tactical Flight Combat Suit (TFCS) with USAF COMBAT EDGE with ATAGS, both extended coverage anti-G trousers with pressure breathing during G. No statistically significant differences were found between the different equipment. HOWEVER, 90% of the subjects were capable of endure 60 s at

DISTRIBUTION STATEMENT A  
Approved for public release;  
Distribution Unlimited

AO F 99-05-0857

19990204 010

9 G with the TFCS with full pressure, 73% at reduced pressure and 60% wearing the COMBAT EDGE with ATAGS with full pressure. While reduced pressure in the extended coverage G-suit -- combined with positive pressure breathing -- may statistically affect G-tolerance, the effectiveness of these combined technologies provide pilots sufficient G-tolerance to meet operational requirements. Noteworthy among the simulated aerial combat maneuver G-profiles were 3 subjects who endured more than 9 mins of exposure before stopping; 1 subject completed 12.5 mins (35 cycles). Results of the study was presented at 1993 Aerospace Medical Association's annual scientific meeting in Toronto, Canada (2) and at the International Congress of Aviation and Space Medicine in Hamburg 1993 and were published in its proceedings (3, 4).

Other research involved development of a remote control of transcranial Doppler (TCD) probe during centrifuge exposures up to 9 +Gz. The Doppler probe and three electrical motors were mounted on a tightly fitted helmet. Remote control of these motors allows precise tilting and sliding of the probe at during G-exposures. Position of the probe at different G-levels are recorded when a good flow velocity signal is achieved. On succeeding G-exposures the probe is moved to the predicted positions for different G-loads when the G-load changes. With this device, blood flow velocity in the middle cerebral artery can be registered at G-loads up to 9 +Gz with increased accuracy. The device should be able to use in future acceleration physiology research both in basic and more applied studies of equipment development. The results of this development have been presented at SAFE Symposium 1993 and published in SAFE Journal (5). A computer program to automate the probe movement process is also under development.

Another cooperative project dealing with more basic acceleration physiology research involved echocardiographic assessment of right ventricular response following release of simulated +Gz stress using the lower body negative pressure technique together with LP Krock, NL Hopper, DA Ludwig and WG Squires. Still another project involved cerebral artery blood flow velocity changes following removal of presyncopal simulated high +Gz stress using similar G-simulation technique together with the same authors. The results of these studies are to be analyzed.

## REFERENCES

1. Krock LP, Russell RL, Siegborn J, Balldin UI. Reduced pressure in extended coverage anti-G trousers with assisted pressure breathing. *Aviat. Space Environ. Med.* 1994; 65:287-92.
2. Balldin U, DA Diesel. Advances in sustained +Gz acceleration protection. *Aerospace Medical Association 64th Annual Scientific Meeting Program.* 1993; A57:541.
3. Balldin UI. Benefits of extended coverage anti-G suit with PBG. *Proceedings. 41st International Congress of Aviation and Space Medicine, Hamburg 1993.* Ed. J Draeger and R Schwartz. Monduzzi Editore. International Proceedings Division. Bologna, Italy. 1994: 223-226.
4. Balldin UI, LP Krock, J Linder, J Siegborn. The need for limiting extended simulated aerial combat maneuver G-exposures in acceleration research. *Proceedings. 41st International Congress of Aviation and Space Medicine, Hamburg 1993.* Ed. J Draeger and R Schwartz. Monduzzi Editore. International Proceedings Division. Bologna. Italy. 1994; 237-240.
5. Balldin UI, P Werchan, T Eddy. Remote control of transcranial Doppler (TCD) probe during centrifuge exposures up to 9 +Gz. *SAFE JOURNAL* 1994; 24 (1): 36-42.