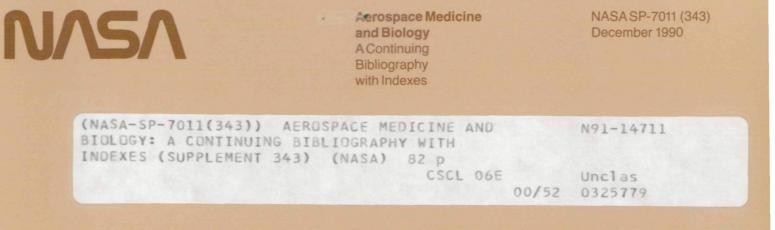
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National Aeronautics and Space Administration

# **Aerospace Medicine & Biology** space Medicine & Biology Aer Medicine & Biology Aerospace dicine & Biology Aerospace Me ne & Biology Aerospace Medic **Biology Aerospace Medicine & Ty Aerospace Medicine & Biol** Prospace Medicine & Biology A pace Medicine & Biology Aeros **Vedicine & Biology Aerospace** cine & Biology Aerospace Med

# ACCESSION NUMBER RANGES

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Accession numbers cited in this Supplement fall within the following ranges.

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# NASA SP-7011(343)

# AEROSPACE MEDICINE AND BIOLOGY

# A CONTINUING BIBLIOGRAPHY WITH INDEXES

# (Supplement 343)

A selection of annotated references to unclassified reports and journal articles that were introduced into the NASA scientific and technical information system and announced in November 1990 in

- Scientific and Technical Aerospace Reports (STAR)
- International Aerospace Abstracts (IAA).



National Aeronautics and Space Administration Office of Management Scientific and Technical Information Division Washington, DC 1990 .

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This supplement is available from the National Technical Information Service (NTIS), Springfield, Virginia 22161, price code A05.

# INTRODUCTION

This Supplement to Aerospace Medicine and Biologylists 217 reports, articles and other documents announced during November 1990 in Scientific and Technical Aerospace Reports (STAR) or in International Aerospace Abstracts (IAA). The first issue of the bibliography was published in July 1964.

In its subject coverage, *Aerospace Medicine and Biology* concentrates on the biological, physiological, psychological, and environmental effects to which man is subjected during and following simulated or actual flight in the Earth's atmosphere or in interplanetary space. References describing similar effects on biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors receive appropriate attention. In general, emphasis is placed on applied research, but references to fundamental studies and theoretical principles related to experimental development also qualify for inclusion.

Each entry in the bibliography consists of a bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by *STAR* categories 51 through 55, the Life Sciences division. The citations, and abstracts when available, are reproduced exactly as they appeared originally in *IAA* or *STAR*, including the original accession numbers from the respective announcement journals. The *IAA* items will precede the *STAR* items within each category.

Seven indexes — subject, personal author, corporate source, foreign technology, contract, report number, and accession number — are included.

An annual index will be prepared at the end of the calendar year covering all documents listed in the 1990 Supplements.

Information on the availability of cited publications including addresses of organizations and NTIS price schedules is located at the back of this bibliography.

# TABLE OF CONTENTS

		r	aye	
Category	51	Life Sciences (General)	305	
Inc	cludes	Aerospace Medicine physiological factors; biological effects of radiation; and effects of sness on man and animals.	309	
	cludes	<b>Behavioral Sciences</b> psychological factors; individual and group behavior; crew training and n; and psychiatric research.	317	
		Man/System Technology and Life Support human engineering; biotechnology; and space suits and protective	320	
		Space Biology exobiology; planetary biology; and extraterrestrial life.	338	
Subject Index A-1				
Personal Author Index B-1				
Corporate Source Index C-1				
Foreign Technology Index D-1				
Contract Number Index E-1				
	Report Number Index F-1			
Accession Number Index				

# **TYPICAL REPORT CITATION AND ABSTRACT**

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ACCESSION NUMBER ------ N90-10571\*# Virginia Univ., Charlottesville. Dept. of Environmental

CONTRACT NUMBER \_\_\_\_\_ REPORT NUMBERS \_\_\_\_\_ COSATI CODE \_\_\_\_\_ A SIMPLE, MASS BALANCE MODEL OF CARBON FLOW IN A CONTROLLED ECOLOGICAL LIFE SUPPORT SYSTEM JAY L. GARLAND Mar. 1989 37 p Prepared in cooperation with Bionetics Corp., Cocoa Beach, FL (Contract NAS10-10285)

(NASA-TM-102151; NAS 1.15:102151) Avail: NTIS HC A03/MF A01 - CSCL 05/8

Internal cycling of chemical elements is a fundamental aspect of a Controlled Ecological Life Support System (CELSS). Mathematical models are useful tools for evaluating fluxes and reservoirs of elements associated with potential CELSS configurations. A simple mass balance model of carbon flow in CELSS was developed based on data from the CELSS Breadboard project at Kennedy Space Center. All carbon reservoirs and fluxes were calculated based on steady state conditions and modelled using linear, donor-controlled transfer coefficients. The linear expression of photosynthetic flux was replaced with Michaelis-Menten kinetics based on dynamical analysis of the model which found that the latter produced more adequate model output. Sensitivity analysis of the model indicated that accurate determination of the maximum rate of gross primary production is critical to the development of an accurate model of carbon flow. Atmospheric carbon dioxide was particularly sensitive to changes in photosynthetic rate. The small reservoir of CO2 relative to large CO2 fluxes increases the potential for volatility in CO2 concentration. Feedback control mechanisms regulating CO2 concentration will probably be necessary in a CELSS to reduce this system instability.

Author

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# **TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT**

	NASA SPONSORED
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ACCESSION NUMBER	A90-11091* Krug International, San Antonio, TX.
	DETERMINING A BENDS-PREVENTING PRESSURE FOR A
	SPACE SUIT
AUTHORS	
	Services Div., San Antonio, TX), and G. A. DIXON (USAF, School of
	Aerospace Medicine, Brooks AFB, TX) SAFE Journal, vol. 19,
PUBLICATION DATE	
	(Contract NASA ORDER T-82170)
	Copyright
	Research conducted to determine the proper pressure for
	preventing bends during EVA without preoxygenation is examined. Male and female subjects with different breathing gas mixtures and
	pressures are studied in order to define the pressure. Visual and
	auditory Doppler ultrasonic signals are utilized to monitor intravascular
	gas bubbles. The workload, which simulates EVA, consists of a
•	handturned bicycle ergometer, a torque wrench operation, and a rope
	pull. The experimental data reveal that the minimum space suit
	pressure needed to prevent decompression sickness is 9.5 psi.

I.F.

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# AEROSPACE MEDICINE AND BIOLOGY A Co

A Continuing Bibliography (Suppl. 343)

# DECEMBER 1990

### 51

### LIFE SCIENCES (GENERAL)

#### A90-46523

#### THE EFFECT OF HYPERTHERMIA ON THE CARDIOVASCULAR SYSTEM AND ACID-BASE COMPOSITION OF BLOOD IN DOGS [VLIIANIE PEREGREVANIIA SOBAK NA KARDIO- I GEMODINAMIKU I KISLOTNO-OSNOVNOE SOSTOIANIE KROVI]

T. V. SHIMANSKAIA, M. I. GUREVICH, V. F. SAGACH, and V. I. BOIKO (AN USSR, Institut Fiziologii, Kiev, Ukrainian SSR) Fiziologicheskii Zhurnal (Kiev) (ISSN 0201-8489), vol. 36, May-June 1990, p. 14-20. In Russian. refs

#### Copyright The effect

The effect of severe hyperthermia on the cardiovascular system of dogs, and the related change of gas and acid-base content of the blood, has been examined. An explanation for the development of system hypotension under conditions of severe hyperthermia is also sought. Results suggest that the observed decrease in the cardiac output during severe hyperthermia is due to the fall of central venous pressure and to the increase of vascular compliance, as exhibited in the musculocutaneous region. Hemodynamic shifts are observed on the background of a disturbance in the acid-base composition of blood. Metabolic asidosis in blood testifies to the accumulation of insufficiently oxidized products of exchange, an activity which may be one reason for increasing vascular compliance. L.K.S.

#### A90-46524

#### THE CHRONIC EFFECT OF AN ELECTROSTATIC FIELD ON CERTAIN BIOCHEMICAL INDICES OF TISSUES [VLIIANIE KHRONICHESKOGO DEISTVIIA ELEKTROSTATICHESKOGO POLIA NA NEKOTORYE BIOKHIMICHESKIE POKAZATELI TKANEI]

E. A. ROMODANOVA, A. V. PARANICH, and L. A. CHAIKINA (Khar'kovskii Gosudarstvennyi Universitet, Kharkov, Ukrainian SSR) Fiziologicheskii Zhurnal (Kiev) (ISSN 0201-8489), vol. 36, May-June 1990, p. 30-34. In Russian. refs Copyright

The effects of an electrostatic field (ESF) of approximately 320 kV/m on the tissue of 32 female white Wistar rats, three months of age were investigated. The rats were exposed to the ESF for six hours per day for a period of three weeks. They were then decapitated and the brain and liver extracted and stored in liquid nitrogen. A homogenate of brain and liver in blood serum was analyzed for its content of glucose, general lipids, triglycerides, phospholipids, cholesterol, glycogen, free fatty acids, ketonic bodies, and flourescent lipopigments. Carbohydrates, lipids, protein metabolism, and the process of lipid peroxidation were also observed in blood serum, liver and brain. Glucose content was observed to increase in all tissues, and the urea and malondialdehyde increased in the liver and brain. L.K.S.

#### A90-46652 DID MEMBRANE ELECTROCHEMISTRY PRECEDE TRANSLATION?

C. C. KING (Auckland, University, New Zealand) Origins of Life and Evolution of the Biosphere (ISSN 0169-6149), vol. 20, no. 1, 1990, p. 15-25. refs Copyright

The discovery of RNA-based enzymes, such as ribonuclease-P, has stimulated new interest in the idea that catalytic functions of RNA preceded the use of coded enzymes during an era loosely termed 'the RNA world'. This paper examines various lines of evidence which support the idea that electrochemical processes associated with the membrane may have preceded the development of coded protein enzymes and may have provided a basis for the phosphorylation energy of the RNA world. Author

#### A90-46654

# CHEMICAL STRUCTURE OF A PREBIOTIC ANALOG OF ADENOSINE

MARIE-CHRISTINE MAUREL (CNRS, Institut Jacques Monod, Paris, France) and ODILE CONVERT (CNRS, Laboratoire de Chimie Organique Structurale, Paris, France) Origins of Life and Evolution of the Biosphere (ISSN 0169-6149), vol. 20, no. 1, 1990, p. 43-48. refs

Copyright

Upon heating a dry mixture of ribose and adenine, condensation products are formed. They were identified as isomers of N6-ribosyl-adenine (Fuller, Sanchez and Orgel, 1972). Due to the current interest in nucleotide analogs as potential constituents of primitive RNA catalysts, the products were further characterized by mass spectroscopy and proton NMR. The results presented here fully substantiate the previous proposals. Author

#### A90-46655

# RADIATION-INDUCED POLYMERIZATION IN DILUTE AQUEOUS SOLUTIONS OF CYANIDES

S. I. VUJOSEVIC, Z. D. DRAGANIC (Institut za Nuklearne Nauke, Belgrade, Yugoslavia), and A. NEGRON-MENDOZA (Universidad Nacional Autonoma de Mexico, Coyoacan, Mexico) Origins of Life and Evolution of the Biosphere (ISSN 0169-6149), vol. 20, no. 1, 1990, p. 49-54. refs

Copyright

It has been found that the addition polymerization of cyanides (HCN and NH4CN) takes place in dilute, O2-free irradiated aqueous solutions, in addition to the abundant formation of various smaller molecules. A polymer with a molecular mass of 16,000 amu was found. Its abundance increases with initial cyanide concentration and absorbed dose and can be up to 31 percent of the total amount of radiolytic products. HPLC data also indicate the presence of two more products at 22,000 amu and 10,000 amu, which are less abundant by one order of magnitude. The same molecular masses appear throughout the examined range of cyanide concentration (0.001-0.2 mol/cu dm) and absorbed dose (2-200 kGy). They remain also at large doses (up to 1250 kGy) after a complete destruction of cyanide.

#### A90-48091

REPORT ON THE WORKSHOP - 'CHEMICAL EVOLUTION AND NEO-ABIOGENESIS IN MARINE HYDROTHERMAL SYSTEMS' NILS G. HOLM (Stockholm, Universitet, Sweden) (International Society for the Study of the Origin of Life and Ceskoslovenska Akademie Ved, Meeting, Prague, Czechoslovakia, July 4-11, 1989) Origins of Life and Evolution of the Biosphere (ISSN 0169-6149), vol. 20, no. 2, 1990, p. 93-98. refs Copyright

#### A90-48100

#### DIFFERENT EFFECTS OF EUBACTERIAL AND EUKARYOTIC DNA TOPOISOMERASE II INHIBITORS ON CHLOROPLASTS OF EUGLENA GRACILIS

JURAJ KRAJCOVIC and LIBOR EBRINGER (Komenskeho Univerzita, Bratislava, Czechoslovakia) (International Society for the Study of the Origin of Life and Ceskoslovenska Akademie Ved, Meeting, Prague, Czechoslovakia, July 4-11, 1989) Origins of Life and Evolution of the Biosphere (ISSN 0169-6149), vol. 20, no. 2, 1990, p. 177-180. refs Copyright

#### A90-48199

#### PARTICIPATION OF CEREBRAL NORADRENERGIC STRUCTURES IN THERMOREGULATION DURING THE ADAPTATION TO COLD [UCHASTIE NORADRENERGICHESKIKH STRUKTUR MOZGA V TERMOREGULIATSII PRI ADAPTATSII K KHOLODU]

IU. I. BAZHENOV and L. R. MIKHAILOVA (Ivanovskii Gosudarstvennyi Universitet, Ivanovo, USSR) Fiziologicheskii Zhurnal SSSR (ISSN 0015-329X), vol. 76, April 1990, p. 523-527. In Russian. refs

Copyright

The effect of noradrenaline on the central thermoregulation mechanism and the participation of the central beta-adrenoreceptor in this mechanism are investigated. Noradrenaline is injected into the cerebral lateral ventricles of white rats and is found to change temperature homeostasis, as indicated by a fall in rectal temperature, rise of brown adipose tissue temperature, and increase in oxygen consumption which was observed within 25-30 min after the injection. Conversely, lack of a rise in brown adipose tissue temperature and absence of an oxygen consumption increase indicate that a beta-adrenergic blockade of cerebral structures induced by propranolol altered the noradrenaline effect. This effect is more pronounced in animals which are adapted to cold, as it appears to increase the sensitivity of central adrenergic structures to noradrenaline due to the role of central beta-adrenoreceptors in the effect of noradrenaline on thermoregulation. L.K.S.

#### A90-48200

#### THE INFLUENCE OF SEROTONINE AND HISTAMINE, INTRODUCED IN SMALL DOSES, ON BODY TEMPERATURE [VLIIANIE SEROTONINA I GISTAMINA, VVODIMYKH V MALYKH DOZAKH, NA TEMPERATURU TELA]

V. A. PEREVERZEV and A. I. KUBARKO (Minskii Gosudarstvennyi Meditsinskii Institut, Minsk, Belorussian SSR) Fiziologicheskii Zhurnal SSSR (ISSN 0015-329X), vol. 76, April 1990, p. 528-533. In Russian. refs

Copyright

The effect of serotonine and histamine on the thermoregulation system is studied. Experiments on white rats and mice show that intraventricular administration of serotonine (10 mg) or interabdominal administration of histamine (0.5 mg/kg) do not affect body temperature. Simultaneous administration of these drugs, however, leads to a drop of body temperature due to intensification of the heat output and the inhibition of heat reduction. It is concluded that these biogenic amines seem to act as substances with additive hypothermal properties and are likely to be the components of the natural antipyretic system of a warm-blooded organism. L.K.S.

#### A90-48584

### ANTI-LPS ANTIBODIES REDUCE ENDOTOXEMIA IN WHOLE BODY CO-60 IRRADIATED PRIMATES - A PRELIMINARY REPORT

M. T. WELLS, S. L. GAFFIN, B. C. WESSELS, J. G. BROCK-UTNE,

J. P. JORDAAN (Natal, University, Durban, Republic of South Africa) et al. Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Sept. 1990, p. 802-806. Research supported by the Beare Foundation, South African Medical Research Council, and Kennedy-Potts Cancer Association. refs Copyright

A previously established primate model was used to evaluate the role of lipopolysaccharide (LPS, endotoxin) in radiation sickness. Vervet monkeys were Co-60 irradiated with an LD100 exposure and had periodic blood samples taken for the determination of LPS and anti-LPS IgG antibodies and for bacteriological studies. On day 2 postirradiation, primates were treated with either sterile 0.9 percent saline, or equine anti-LPS hyperimmune plasma, or tripotassium-dicitrato-bismuthate (Denol). Results indicate that anti-LPS-treated animals survived significantly longer than both the other groups and, since LPS may cause nausea, vomiting, diarrhea, anorexia, and headaches, it is suggested that Anti-LPS administration may be of value in reducing plasma LPS concentration in humans and improving their performance and survivability. L.K.S.

### A90-48585\* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

# THE SUSCEPTIBILITY OF RHESUS MONKEYS TO MOTION SICKNESS

MERYL L. CORCORAN, NANCY G. DAUNTON (NASA, Ames Research Center, Moffett Field, CA), and ROBERT A. FOX (San Jose State University, CA) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Sept. 1990, p. 807-809. refs

#### Copyright

The susceptibility of rhesus monkeys to motion sickness was investigated using test conditions that are provocative for eliciting motion sickness in squirrel monkeys. Ten male rhesus monkeys and ten male Bolivian squirrel monkeys were rotated in the vertical axis at 150 deg/s for a maximum duration of 45 min. Each animal was tested in two conditions, continuous rotation and intermittent rotation. None of the rhesus monkeys vomited during the motion tests but all of the squirrel monkeys did. Differences were observed between the species in the amount of activity that occurred during motion test, with the squirrel monkeys being significantly more active than the rhesus monkeys. These results, while substantiating anecdotal reports of the resistance of rhesus monkeys to motion sickness, should be interpreted with caution because of the documented differences that exist between various species with regard to stimuli that are provocative for eliciting motion sickness. Author

#### A90-48587\* California Univ., Los Angeles. CHANGES IN GEOMETRICAL AND BIOMECHANICAL PROPERTIES OF IMMATURE MALE AND FEMALE RAT TIBIA

RONALD F. ZERNICKE, JACK C.-H. HOU, ARTHUR C. VAILAS, MITCHELL NISHIMOTO, SANJAY PATEL (California, University, Los Angeles) et al. Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Sept. 1990, p. 814-820. Research supported by PHS and University of California. refs (Contract NCA2-IR-390-501)



The differences in the geometry and mechanical properties of immature male and female rat tibiae were detailed in order to provide comparative data for spaceflight, exercise, or disease experiments that use immature rats as an animal model. The experiment focuses on the particularly rapid period of growth that occurs in the Sprague-Dawley rat between 40 and 60 d of age. Tibial length and middiaphysical cross-sectional data were analyzed for eight different groups of rats according to age and sex, and tibial mechanical properties were obtained via three-point bending tests to failure. Results indicate that, during the 15 d period of rapid growth, changes in rat tibial geometry are more important than changes in bone material properties for influencing the mechanical properties, while in the female rats major changes in

mechanical properties of the tibia were only attributable to changes in the structural properties of the bone. LKS

#### A90-49041\* Wright State Univ., Dayton, OH. RU 24969-INDUCED EMESIS IN THE CAT - 5-HT1 SITES OTHER THAN 5-HT1A, 5-HT1B OR 5-HT1C IMPLICATED JAMES B. LUCOT (Wright State University, Dayton, OH) European Journal of Pharmacology (ISSN 0014-2999), vol. 180, 1990, p. 193-199. refs (Contract NCC2-229)

Copyright

RU 24969 was administered s.c. to cats and found to elicit emesis with a maximally effective dose of 1.0 mg/kg 5-Methoxytryptamine was found to have lower efficacy and to produce a higher incidence of nonspecific effects while trifluoromethylphenylpiperizine (TFMPP) was devoid of emetic effects. The emesis elicited by 1.0 mg/kg of RU 24969 was not altered by pretreatment with phentolamine, haloperidol, yohimbine or (-)-propranolol, indicating that catecholamines played no role in this response. The emesis was prevented by metergoline and methysergide but not by ketanserin, cyproheptadine, mesulergine, ICS 205 930, methiothepin, trimethobenzamide or BMY 7378. An indirect argument is presented that implicates a role for 5-HT1D sites. This conclusion must remain tentative until drugs selective for this site are synthesized and tested. The emesis was also prevented by 8-hydroxy-2-(di-n-propylamine)tetralin (8-OH-DPAT), confirming that this drug has a general antiemetic effect in cats. Author

### A90-49047\* Massachusetts Eye and Ear Infirmary, Boston. THE CHINCHILLA'S VESTIBULO-OCULAR REFLEX

W. H. MERWIN, JR. (Nalle Clinic, Charlotte, NC), CONRAD WALL, III (Massachusetts Eye and Ear Infirmary, Boston), and D. L. TOMKO (NASA, Ames Research Center, Moffett Field, CA) Acta Oto-Laryngologica (ISSN 0001-6489), vol. 108, 1989, p. 161-167. Research supported by the University of Pittsburgh. refs (Contract NAG9-113; NAG2-155; NIH-NS-21819; NIH-NS-17585) Copyright

The horizontal vestibulo-ocular reflex (VOR) was measured and characterized in seven adult chinchillas using 0.01 to 1.0 Hz angular velocity sinusoids. Gains were less than compensatory, and were variable from day to day, but phases were highly repeatable both within and between animals. The best fitting transfer function to the average data of all animals had a dominant time constant of 7.5 sec, and an adaptation operator with a time constant of 24.0 sec. There were certain nonlinearities in the horizontal VOR of this animal, and it was difficult to elicit a robust optokinetic response. Results are discussed in relation to similar measurements in other species. Author

A90-49049\* National Aeronautics and Space Administration.

# Ames Research Center, Moffett Field, CA. 3-D COMPONENTS OF A BIOLOGICAL NEURAL NETWORK VISUALIZED IN COMPUTER GENERATED IMAGERY. II -MACULAR NEURAL NETWORK ORGANIZATION

MURIEL D. ROSS (NASA, Ames Research Center, Moffett Field, CA), GLENN MEYER, TONY LAM, LYNN CUTLER, and PARSHAW VAZIRI (Sterling Software, Palo Alto, CA) Acta Oto-Laryngologica (ISSN 0001-6489), vol. 109, 1990, p. 235-244. refs Copyright

Computer-assisted reconstructions of small parts of the macular neural network show how the nerve terminals and receptive fields are organized in 3-dimensional space. This biological neural network is anatomically organized for parallel distributed processing of information. Processing appears to be more complex than in computer-based neural network, because spatiotemporal factors figure into synaptic weighting. Serial reconstruction data show anatomical arrangements which suggest that (1) assemblies of cells analyze and distribute information with inbuilt redundancy, to improve reliability; (2) feedforward/feedback loops provide the capacity for presynaptic modulation of output during processing; (3) constrained randomness in connectivities contributes to adaptability; and (4) local variations in network complexity permit

differing analyses of incoming signals to take place simultaneously. The last inference suggests that there may be segregation of information flow to central stations subserving particular functions. Author

A90-49053\* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

### INFLUENCE OF GRAVITY ON CAT VERTICAL **VESTIBULO-OCULAR REFLEX**

D. L. TOMKO (NASA, Ames Research Center, Moffett Field, CA; Pittsburgh, University, PA), C. WALL, III, F. R. ROBINSON, and J. P. STAAB (Pittsburgh, University, PA) Experimental E Research (ISSN 0014-4819), vol. 69, 1988, p. 307-314. refs Experimental Brain (Contract NAG2-155; NAG9-113; NIH-NS-17585; NIH-NS-21819) Copyright

The vertical vestibulo-ocular reflex (VOR) was recorded in cats using electro-oculography during sinusoidal angular pitch. Peak stimulus velocity was 50 deg/s over a frequency range from 0.01 to 4.0 Hz. To test the effect of gravity on the vertical VOR, the animal was pitched while sitting upright or lying on its side. Upright pitch changed the cat's orientation relative to gravity, while on-side pitch did not. The cumulative slow component position of the eye during on-side pitch was less symmetric than during upright pitch. Over the mid-frequency range (0.1 to 1.0 Hz), the average gain of the vertical VOR was 14.5 percent higher during upright pitch than during on-side pitch. At low frequencies (less than 0.05 Hz) changing head position relative to gravity raised the vertical VOR gain and kept the reflex in phase with stimulus velocity. These results indicate that gravity-sensitive mechanisms make the vertical VOR more compensatory. Author

### A90-49299

# PLANT BIOLOGY RESEARCH ON 'LIFESAT'

ABRAHAM D. KRIKORIAN (New York, State University, Stony Brook) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 18 p. refs

(SAE PAPER 901227) Copyright

'LifeSat' provides unique research opportunities and capabilities for plant biologists. It could provide a regular schedule of flight opportunities to test and investigate a number of important questions in Space biology and gravi-morphogenesis. It could provide a long duration Space environment with much lower levels of g perturbation than might otherwise be possible in the Shuttle or on Space Station Freedom. Since it would be unmanned, one would have access to self-contained, hence more reliable, data gathering than would occur in man-operated experiments. Additionally, if polar flights are implemented,' LifeSat' provides an opportunity to study interaction of micro-g, hypo-g and radiation. A number of research areas are outlined against a background of plant science objectives and some examples of potential mission scenarios are presented. B.M.

A90-49300\* Jet Propulsion Lab., California Inst. of Tech., Pasadena.

# LIFESAT - RADIATION RESEARCH

GREGORY A. NELSON (JPL, Pasadena, CA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 7 p.

(SAE PAPER 901228) Copyright

Spaceflight crews will be exposed to levels of radiation which exceed those experienced on the ground. In order to reduce the uncertainty in the evaluation of risks it is necessary to validate the responses of biological systems in space under conditions which simulate exposure levels expected during exploration class missions. The LifeSat system provides the experimental capabilities to satisfy these goals. Specifically, LifeSat is capable of long duration flights of up to 60 days, is able to fly directly into trapped radiation belts and in circular or eccentric polar orbits, has the ability to provide artificial gravity and imposes fewer restrictions than the STS on the use of hazardous materials such as chemical fixatives. These features along with reference missions and experiments are discussed with respect to radiation research goals. Author

#### A90-49330\* Krug International, Houston, TX. MICROBIOLOGY FACILITIES ABOARD SPACE STATION FREEDOM (SSF)

L. A. CIOLETTI, S. K. MISHRA, ELIZABETH E. RICHARD (Krug International, Technology Life Sciences Div., Houston, TX), and R. TAYLOR (NASA, Johnson Space Center, Houston, TX) SAE Intersociety Conference on Environmental Systems, 20th. Williamsburg, VA, July 9-12, 1990. 6 p. refs

(SAE PAPER 901262) Copyright

A comprehensive microbiological facility is being designed for use on board Space Station Freedom (SSF). Its purpose will be to conduct microbial surveillance of the SSF environment and to examine clinical specimens. Air, water, and internal surfaces will be periodically monitored to satisfy requirements for a safe environment. Crew health will remain a principle objective for every mission. This paper will review the Microbiology Subsystem capabilities planned for SSF application. Author

A90-49355\* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

#### FACILITIES FOR ANIMAL RESEARCH IN SPACE WITH SPECIAL REFERENCE TO SPACE STATION FREEDOM

SJOERD L. BONTING (SETI Institute, Moffett Field, CA), JENNY S. KISHIYAMA, and ROGER D. ARNO (NASA, Ames Research Center, Moffett Field, CA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 24 p. refs (SAE PAPER 901303) Copyright

The facilities being planned for animal research on Space Station Freedom are considered in the context of the development of animal habitats from early ballistic and orbital flights to long-term missions aimed at more detailed scientific studies of the effects of space conditions on the vertebrate organism. Animal habitats are becoming more elaborate, requiring systems for environmental control, waste management, physiological monitoring, as well as ancillary facilities such as a 1-G control centrifuge and a glovebox. Habitats in use or to be used in various types of manned and unmanned spacecraft, and particularly those planned for Space Station Freedom, are described. The characteristics of the habitats are compared with each other and with current standards for animal holding facilities on the ground. Author

#### A90-49356\* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

#### **RESEARCH CENTRIFUGE ACCOMMODATIONS ON SPACE** STATION FREEDOM

ROGER D. ARNO and MICHAEL J. HORKACHUK (NASA, Ames Research Center, Moffett Field, CA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 11 p. refs

### (SAE PAPER 901304) Copyright

Life sciences research using plants and animals on the Space Station Freedom requires the ability to maintain live subjects in a safe and low stress environment for long durations at microgravity and at one g. The need for a centrifuge to achieve these accelerations is evident. Programmatic, technical, and cost considerations currently favor a 2.5 meter diameter centrifuge located either in the end cone of a Space Station Freedom node or in a separate module. A centrifuge facility could support a mix of rodent, plant, and small primate habitats. An automated cage extractor could be used to remove modular habitats in pairs without stopping the main rotor, minimizing the disruption to experiment protocols. The accommodation of such a centrifuge facility on the Space Station represents a significant demand on the crew time, power, data, volume, and logistics capability. It will contribute to a better understanding of the effects of space flight on humans, an understanding of plant growth in space for the eventual production of food, and an understanding of the role of gravity in biological processes. B.P.

### A90-49369

#### A GENERALIZED PHOTOSYNTHETIC MODEL FOR PLANT **GROWTH WITHIN A CLOSED ARTIFICIAL ENVIRONMENT**

ROBERT L. HEATH, MONICA A. MADORE (California, University, Riverside), and RACHEL M. S. HURD (McDonnell Douglas Space Systems Co., Huntington Beach, CA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 16 p. refs

(SAE PAPER 901331) Copyright

A generalized model of plant growth has been developed with a view to tests of the variations in mass flows and chemical/energy transformations that are possible within a closed artificial environment. Attention is given to mass transfers through the photosynthetic processes, leaf radiation/heat balances, and carbohydrate production/distribution; the generalization of a full plant's growth proceeds from the radiative loading and gas exchange capacities of a single leaf. The mathematical description of photosynthesis employed uses an exponential function for light dependence multiplied by a hyperbolic function for CO2/O2 levels: this keeps dependent variables to a minimum. The model is incorporated into a FORTRAN subroutine allowing its use in the CASE/A-CELSS version of NASA's ECLS system-simulation program. O.C.

#### A90-49383

### SUPERHELICITY AND DNA RADIATION SENSITIVITY

CHARLES E. SWENBERG, ERIC A. HOLWITT, and JAMES M. SPEICHER (Armed Forces Radiobiology Research Institute, Bethesda, MD) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 9 p. refs (SAE PAPER 901349) Copyright

Several underwound families of topoisomers of the plasmid pIB130 were irradiated with fission neutrons at 28 c in TE buffer. Form I DNA followed the expected exponential dependence on dose, and was greater for those DNA molecules characterized by larger linking numbers. The radiation sensitivity was found to be linearly related to average linking difference. This enhanced radiation sensitivity is tentatively attributed to the increased number of transient open states that closed DNA experiences with increasing superhelicity. Radioprotectants enhance decrease in the DNA linking number in the presence of topoisomerase I suggests that some of the protection conferred may be due to decreases in DNA superhelicity. Author

# A90-49409\* Harvard Univ., Cambridge, MA. SURVIVAL OF PATHOGENIC BACTERIA UNDER NUTRIENT STARVATION CONDITIONS

MICHAEL BOYLE, TIM FORD, RALPH MITCHELL, and JAMES MAKI (Harvard University, Cambridge, MA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 10 p. Research supported by NASA. refs (SAE PAPER 901381) Copyright

The survival of opportunistic pathogenic microorganisms in water, under nutrient-limiting conditions, has been investigated in order to ascertain whether human pathogens can survive within a water-distribution system of the kind proposed for the NASA Space Station. Cultures of a strain of pseudomonas aeruginosa and two strains of staphylococcus aureus were incubated at 10, 25, or 37 C, and samples at 1 day, 1 week, 1 month, and six weeks. While neither of the staphylococcus strains tested were detected after 1 week of starvation, the pseudomonas strain can survive in deionized water at all three temperatures. 00

#### N90-27239\*# National Aeronautics and Space Administration. Pasadena Office, CA.

**PSEUDOMONAS DIAGNOSTIC ASSAY Patent Application** RUTH MARGALIT, inventor (to NASA) (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 30 Mar. 1990 10 p (Contract NAS7-918)

(NASA-CASE-NPO-17653-1-CU; NAS 1.71:NPO-17653-1-CU; US-PATENT-APPL-SN-501908) Avail: NTIS HC A02/MF A01 CSCL 06C

A method for the detection of Pseudomonas bacteria is described where an Azurin-specific antibody is employed for detecting the presence of Azurin in a test sample. The detectionof the presence of Azurin in the sample is a conclusive indicator of the presence of the Pseudomonas bacteria since the Azurin protein is a specific marker for this bacterial strain. NASA

N90-27240# Kings Coll., London (England). Dept. of Physics. ACCURATE DETERMINATION OF THE COMPLEX

PERMITTIVITY OF BIOLOGICAL TISSUE AT 90 GHZ, 70 GHZ, AND OVER A BROAD BAND AROUND 35 GHZ Interim Report, Oct. 1987 - May 1988 RODNEY J. SHEPPARD Mar. 1990 29 p Prepared for

RODNEY J. SHEPPARD Mar. 1990 29 p Prepared for European Office of Aerospace Research and Development, London, England

(Contract AF-AFOSR-9343-87; AF PROJ. 2312)

(AD-A222062; USAFSAM-TR-89-20) Avail: NTIS HC A03/MF A01 CSCL 06/7

The design of a new experimental system to measure the complex permittivity of liquids and solid tissues at 90 GHz is considered. A circuit diagram is presented, and an experimental cell (sample holder) of circular cross section is described. A numerical method which would enable alternative designs of cell to be considered, is presented. A broad-band system to measure complex permittivity around 35 GHz has been designed, and we confidently believe this equipment can be set up to cover the full bandwidth of 26 to 40 GHz. GRA

#### N90-27241# Pacific-Sierra Research Corp., Los Angeles, CA. EFFECTS OF PROTRACTED IONIZING RADIATION DOSAGE ON HUMANS AND ANIMALS: A BRIEF REVIEW OF SELECTED INVESTIGATIONS Technical Report, 5 Jun. 1984 - 31 Jan. 1985

G. H. ANNO and S. J. BAUM 1 Jun. 1990 67 p (Contract DNA001-84-C-0289; DA PROJ. RN) (AD-A222240; PSR-1687; DNA-TR-87-28) Avail: NTIS HC A04/MF A01 CSCL 06/7

A review of selected investigations of animal irradiation studies, radiation therapy experience, and radiation accident accounts is presented, and some acute effects of protected ionizing radiation exposure on animals and humans are discussed. Various guidelines and models, which account for biological recovery when radiation exposure is protracted over time, are compared. Biological response modifying effects of dose rate and protraction period in humans are discussed in terms of prodromal symptoms. Radiation injury and recovery in a variety of animals, based on the LD(50) endpoint, are reviewed and summarized for low and high dose rates ranging from 0.5 to about 700 R/h. Biological recovery models and guidelines are empirical and are primarily based on radiation injury accumulation is animals and gauged by the LD(50) endpoint. Further development of appropriate protracted dose models is relevant and necessary for military operations and emergency civil defense planning. GRA

#### N90-27242# Catholic Univ. of America, Washington, DC. MECHANISMS OF MICROWAVE INDUCED DAMAGE IN BIOLOGIC MATERIALS Annual Report, 22 Sep. 1988 - 21 Sep. 1989

T. A. LITOVITZ, R. MEISTER, R. K. MOHR, C. J. MONTROSE, J. M. MULLINS, R. M. NARDONE, and M. PENAFIEL Jan. 1990 113 p

(Contract DAMD17-86-C-6260; DA PROJ. 3E1-62787-A-878) (AD-A222454) Avail: NTIS HC A06/MF A01 CSCL 06/1

This report is divided into four chapters which correspond to the four main lines of research being carried out under the contract. In brief, these are: (1) mathematical modeling studies, (2) experimental spectroscopic studies, (3) engineering design research, and (4) experimental biological studies. The research program is structured to attempt to discover the biological effects at the cell and molecular level that result from exposure to electromagnetic radiation. The main thrust is on the athermal effects of exposure to microwaves. Because recent work has suggested that significant cellular effects occur only when the microwaves are amplitude modulated, either with extremely low frequency (ELF) sinusoids or with pulses, we have hypothesized that the interaction of the microwave fields with cells must involve a demodulation or detection step. As a result, research designed to develop an understanding of the effects of direct ELF exposure becomes not only relevant, but vital. GRA

N90-27243# Harry Diamond Labs., Adelphi, MD. BIOELECTROMAGNETIC EFFECTS OF THE ELECTROMAGNETIC PULSE (EMP)

EUGENE L. PATRICK and WILLIAM L. VAULT Mar. 1990 20 p

(AD-A221552; HDL-TL-90-2) Avail: NTIS HC A03/MF A01 CSCL 20/5

The public has expressed concern about the biological effects and hazards of non-ionizing electromagnetic fields produced by the electro-magnetic pulse (EMP) simulators that simulate the EMP emanating from a high-altitude nuclear explosion. This paper provides a summary of the bioelectromagnetic effects literature up through the present, describes current occupational standards for workers exposed to the EMP environment, and discusses the use of medical surveillance as it relates to the potential human health hazards associated with exposure to the EMP environment. GRA

N90-28322# Gordon Research Conferences, Inc., Kingston, RI. THE 1989 GORDON RESEARCH CONFERENCE ON

CHRONOBIOLOGY Final Report, 1 Jun. 1989 - 31 May 1990 TERRY L. PAGE and WOODY HASTINGS 1 Apr. 1990 15 p Conference held in Plymouth, NH, 26-30 Jun. 1989

(Contract AF-AFOSR-0321-89; AF PROJ. 2312) (AD-A221972; AFOSR-90-0574TR) Avail: NTIS HC A03/MF A01 CSCL 06/4

One Hundred and fourteen scientist attended the 1989 Gordon Conference on Chronobiology. The program brought together people working at all levels of organization from molecular biology to ecological significance of temporal organization. Two general themes emerged. The first concerned the importance of feedback from circadian rhythm effectors onto the timing system. The second dealt with the significance of the fact that the phase response curves to a variety of phase shifting stimuli appear to fall into only two classes. GRA

# 52

# **AEROSPACE MEDICINE**

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

#### A90-46520

#### EVOKED POTENTIALS DURING PERIODS OF LOOK FIXATION AND PERIODS OF SACCADIC EYE MOVEMENT IN HUMANS [VYZVANNYE POTENTSIALY PRI FIKSATSII VZORA I SAKKADICHESKIKH DVIZHENIIAKH GLAZ CHELOVEKA]

B. KH. BAZIIAN and N. N. LIUBIMOV (AMN SSSR, Nauchno-Issledovatel'skii Institut Mozga, Moscow, USSR) Fiziologiia Cheloveka (ISSN 0131-1646), vol. 16, May-June 1990, p. 28-35. In Russian. refs

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The mechanism of visual suppression (VS) during saccadic eye movements was investigated by measuring evoked potentials (EPs) during periods of look fixation and during saccadic eye movements. Human subjects were presented with light stimuli of 50-microsec duration, and EPs were recorded in occipital and parietal regions of the scalp during periods of eye rest and during rapid eye movement. It was found that, during short flashes and with a homogeneous vision background, the EP components for the resting eyes and the rapidly moving eyes are similar, even though the saccadic eye movements affected recognition of simple symbols presented to subjects.

# 52 AEROSPACE MEDICINE

#### A90-46521

#### USE OF AUTOMATED SYSTEMS FOR THE ASSESSMENT OF THE HEALTH AND THE ADAPTIVE POTENTIALS OF HUMANS [AVTOMATIZIROVANNYE SISTEMY V KOMPLEKSNOI OTSENKE ZDOROV'IA I ADAPTIVNYKH VOZMOZHNOSTEI CHELOVEKA]

E. M. KAZIN, A. D. RIFTIN, A. I. FEDOROV, V. A. PANFEROV, and IU. P. SHORIN (Kemerovskii Gosudarstvennyi Universitet, Kemerovo, USSR) Fiziologiia Cheloveka (ISSN 0131-1646), vol. 16, May-June 1990, p. 94-100. In Russian. refs Copyright

The adaptive potentials of the human organism were assessed by measuring various parameters of the cardiovascular system and vegetative regulation during rest and during the transition period in the course of an orthostatic test, using an automatic rhythmocardiometer and a computer. It is shown that the automated systems make it possible to quickly determine the physical condition of the subject, the effect of stress on the regulatory mechanisms of the cardiovascular system, and the level of adaptive reserves of subjects, taking into account age, sex, somatic type, and functional response.

#### A90-46522

#### ADAPTATION OF TRAINED AND UNTRAINED HUMANS TO NATURAL AND TECHNOGENIC EXTREME FACTORS UNDER THE EFFECT OF ADAPTOGENS [ADAPTATSIIA K PRIRODNYM I TEKHNOGENNYM EKSTREMAL'NYM FAKTORAM U TRENIROVANNYKH I NETRENIROVANNYKH LIUDEI POD VLIIANIEM ADAPTOGENOV]

A. V. LUPANDIN (Institut Fizicheskoi Kul'tury, Khabarovsk, USSR) Fiziologiia Cheloveka (ISSN 0131-1646), vol. 16, May-June 1990, p. 114-119. In Russian. refs

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The effects of tocopherol and of plant adaptogens (a combination of the Schizandra extract and saparal) on the ability of humans to adapt to extreme conditions (physical stress or a long-distance flight) were investigated in trained and untrained subjects, using either the parameters of physical endurance (in male athletes vs untrained active men) or of sensomotor coordination (in long-distance stewardesses before vs after flight). Results demonstrate the significant role of the antioxidant activity of polyphenol adaptogens in the adaptation of both trained and untrained and untrained subjects to extreme conditions.

#### A90-46625 .

#### PHYSIOLOGICAL RESERVES OF THE HUMAN ORGANISM AND THE HIGH-ALTITUDE ENVIRONMENT [FIZIOLOGICHESKIE REZERVY ORGANIZMA I VYSOKOGOR'E]

VIKTOR P. ZAGRIADSKII and ALEKSANDR P. SEROKHVOSTOV Frunze, Izdatel'stvo Ilim, 1989, 120 p. In Russian. refs Copyright

The physiological systems that determine the physiological reserves of a human are examined together with the methods for assessing the magnitude of the reserves. Data are presented showing the effects of age, disease, and altitude hypoxia on the physiological reserves and the adaptive potential of the organism. The data also show the correlation between the physiological reserves of a subject and his work capacity under normal conditions, his tolerance to extreme situations, and the ability to adapt to the hypoxic environment of high mountains.

#### A90-48331

# STRESS-INDUCED DEFICITS OF THE HUMAN IMMUNE

SYSTEM [STRESSORNYE IMMUNODEFITSITY U CHELOVEKA] V. A. LEVANDO, R. S. SUZDAL'SKII, S. N. KUZ'MIN, B. B. PERSHIN (VNIIFK; TsNIIMS; TsNIIVS, Moscow, USSR), and G. N. KASSIL' Uspekhi Fiziologicheskikh Nauk (ISSN 0301-1798), vol. 21, June-Sept. 1990, p. 79-97. In Russian. refs Copyright

The effects of stress on the condition of immune defenses and on the appearance of a secondary immune-response deficit are investigated using literature data on humans and laboratory animals. Particular attention is given to forms of immune deficiency occurring as a result of strenuous physical activity, showing that there may occur a state when blood immunoglobulins might disappear completely, due to abrupt acidification of body fluids leading to an increased protease activity. The paper examines the different phases of the immunohomeostatic adaptation and discusses methods for correcting immune deficiency and as well as for its prevention. I.S.

A90-48583\* Lovelace Foundation for Medical Education and Research, Albuquerque, NM.

#### EFFECTS OF ACUTE HYPOXIA ON CARDIOPULMONARY RESPONSES TO HEAD-DOWN TILT

J. A. LOEPPKY, U. C. LUFT (Lovelace Foundation for Medical Education and Research, Albuquerque, NM), P. SCOTTO (Napoli, Universita, Naples, Italy), and T. W. CHICK (USVA, Medical Center, Albuquerque, NM) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Sept. 1990, p. 785-794. Research supported by AHA. refs (Contract NAG9-375)

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Six male subjects were exposed on two separate occasions to simulated microgravity with 28 deg head-down tilt (HD) for 1 h with baseline followed by recovery at + 17 deg head-up. Pulmonary ventilation, gas exchange, spirometry, and central and cerebral blood flow characteristics were compared while breathing ambient air and reduced F(I)O2 equivalent to 14,828 ft. With hypoxia (HY), the increased tidal volume served to attenuate the drop in arterial saturation by reducing deadspace ventilation. Arterial and mixed venous PO2, values, estimated from peripheral venous samples and cardiac output (CO), were both maintained during HD in HY. Mixed venous PO2 was elevated by an increase in CO associated with a reduction in systemic resistance. Changes in spirometric indices during HD were not accentuated by HY, making the presence of interstitial edema unlikely. Cerebral flow and resistance showed minor reductions with HD. Tissue oxygenation and cardiopulmonary function were not notably effected by HD during HY, but a combination of these two stressors may predispose subjects to subsequent orthostatic intolerance during initial recovery. Author

#### A90-48586\* Texas Univ., Galveston. INTRAOCULAR PRESSURE, RETINAL VASCULAR, AND

### VISUAL ACUITY CHANGES DURING 48 HOURS OF 10-DEG HEAD-DOWN TILT

THOMAS H. MADER (Texas, University, Galveston), GERALD R. TAYLOR (NASA, Johnson Space Center, Houston, TX), NORWOOD HUNTER, MICHAEL CAPUTO (Krug International, Houston, TX), and RICHARD T. MEEHAN (Colorado, University, Denver) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Sept. 1990, p. 810-813. refs (Contract NIH-RR-00073)

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Intraocular pressures, retinal vascular diameters, and visual acuities of nine men, were repeatedly measured while the subjects were tilted 10 deg head-down for 48 h and while they were seated before (baseline), and after the tilt. An immediate increase in intraocular pressure, measured by pneumatonometer was recorded when subjects assumed the head-down position, and diurnal variations in intraocular pressures were observed for the 48 h. The initial and final head-down intraocular pressures were not significantly different. However, when subjects resumed the sitting position, intraocular pressures fell below the initial sitting values. Computer image analysis of the retinal vasculature detected a 6 percent and 2 percent reduction in the caliber of arteries and veins, respectively, as compared with sitting baseline values. No changes in visual acuity were documented during the 48 h of head-down tilt. The data suggest that the choroidal blood reservoir increases in volume over 48 h at continuous head-down position with a compensatory decrease in aqueous volume. These findings may explain intraocular pressure changes noted in astronauts during previous space missions and in studies associated with change in body position. Author

# 52 AEROSPACE MEDICINE

# A90-48588

### HORMONAL CHANGES AFTER PARABOLIC FLIGHT -IMPLICATIONS ON THE DEVELOPMENT OF MOTION SICKNESS

C. DRUMMER, R. L. RIEPL, A. KOENIG (Medizinische Klinik Innenstadt, Munich, Federal Republic of Germany), H. STROMEYER (DLR, Cologne, Federal Republic of Germany), F. STROLLO (Institute for Endocrinological and Metabolic Diseases, Rome, Italy) et al. Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Sept. 1990, p. 821-828. Research supported by BMFT, INRCA, and ESA. refs Copyright

Parabolic flight maneuvers were conducted to induce a model of space motion sickness and subsequent hormonal changes in participating volunteers were measured, including stress parameters, gastrointestinal hormones, and parameters involved in fluid and electrolyte homeostasis. Twenty-two different parameters were measured in all, and present data confirm previous results which indicate that increases in plasma levels of certain stress hormones participate in motion sickness. It is further concluded that increases in vasoactive intestinal peptide levels also participate in motion sickness. It is noted that these increases could explain some of the gastrointestinal symptoms in motion sickness and might serve as markers for a discrimination between regular stress and motion sickness. IKS

#### A90-48589

#### **ALTITUDE DECOMPRESSION SICKNESS - HYPERBARIC** THERAPY RESULTS IN 528 CASES

ROBERT W. WEIEN and NEAL BAUMGARTNER (USAF, School of Aerospace Medicine, Brooks AFB, TX) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Sept. 1990, p. -833-836. refs

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A total of 528 cases of decompression sickness (DCS) resulting from altitude exposure were reviewed during the period January 1, 1977 through December 31, 1986, and treated with hyperbaric therapy. Data collected include age, sex, date and place of origin, duty position, type of exposure, altitude, diagnosis, treatment, and result. Analysis of the data described maximum altitudes of exposure, time to onset of symptoms, diagnosis, and the treatment tables used. Significant results include an increased incidence of altitude DCS requiring hyperbaric therapy among females, no significant difference in incidence rates between duty positions in the altitude chamber exposures reviewed, and confirmation of the efficacy of hyperbaric oxygen therapy. Author

#### A90-48590

### A CASE OF LEFT HYPOGLOSSAL NEURAPRAXIA FOLLOWING G EXPOSURE IN A CENTRIFUGE

MARC S. KATCHEN, TERENCE J. LYONS, KENT K. GILLINGHAM, and WILLIAM SCHLEGEL (USAF, School of Aerospace Medicine, Brooks AFB, TX) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Sept. 1990, p. 837-839. refs Copyright

Isolated hypoglossal (XIIth cranial nerve) neurapraxia is a rare clinical presentation. A case of an isolated hypoglossal neurapraxia following exposure to +7.2 Gz in a human centrifuge. Although a variety of cervical spine injuries have been reported as a result of G exposure in an aircraft, no cranial nerve injuries have been reported. A review of the literature of isolated hypoglossal neurapraxia is presented with discussion of the probable cause of this nerve injury. Author

#### A90-48591

#### POSITIVE PRESSURE BREATHING FOR ACCELERATION **PROTECTION AND ITS ROLE IN PREVENTION OF INFLIGHT G-INDUCED LOSS OF CONSCIOUSNESS**

RICHARD M. HARDING and JOHN B. BOMAR (USAF, School of Aerospace Medicine, Brooks AFB, TX) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Sept. 1990, p. 845-849. refs Copyright

This article reviews positive pressure breathing's (PPB's) background and present use as protection against  $+G_z$  acceleration and summarizes the physiologic basis for its effectiveness before relating it to its undoubted role in support of other anti-G strategies. From theoretical considerations supported by published evidence, it is concluded that while PPB, if used correctly and when combined with other strategies, can enhance tolerance to +Gz acceleration, its principal influence on the occurrence of G-LOC will be by virtue of its ability to increase endurance by decreasing aircrew fatigue. Author

#### A90-48592

# PARTIAL SUPINATION VERSUS GZ PROTECTION

E. H. WOOD, C. F. CODE, and E. J. BALDES (Mayo Medical School, Rochester, MN) Aviation, Space, and Environmental Medicine (ISSN 0095-6562), vol. 61, Sept. 1990, p. 850-858. refs

(Contract N66001-87-C-0079)

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Visual and loss of consciousness endpoints during 2 G/s onset G forces sustained for 5 s in 14 and for 10 s in 27 untrained pilots indicated high tolerances when upright, and increases of more than 3 G when supinated to 60 deg. Protection against visual symptoms of only 1.1 G when tilted 60 deg and especially none when experienced subjects were tilted 45 deg from vertical were expected results in 1942. Subsequent findings by others of slight decreases in tolerance at 30 deg are contrary to hydrostatic basis of G tolerance. Presumably factors other than heart to brain distance affect G tolerance when subjects are supinated 30 deg. It is concluded that the apparent increased incidence of G-LOC since the incorporation of 30 deg seat in F-16 and other fighters in mid-1970's supports the current relevance of these data and suggests that all aircrew should follow the lead to veteran test pilots who sit upright in preparation for and during high G maneuvers. Author

#### A90-48700

#### VISUAL MECHANISMS AND PREDICTORS OF FAR FIELD VISUAL TASK PERFORMANCE

ANDREW V. BARBER (Science Applications International Corp., El Paso, TX) Human Factors (ISSN 0018-7208), vol. 32, April 1990, p. 217-233. refs

(Contract MDA903-85-C-0460)

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Visual mechanisms involved in target detection, recognition, and tracking were examined. Relationships were analyzed in the context of simulated combat, focusing on the short-range air defense weapon operator. Objectives were to identify visual ability interrelations, predictors of performance, and interactions with cuing, target characteristics, and experience. Good predictors included visual acuity, contrast sensitivity, resting focus, near focal point, and blur interpretation. Many of these abilities interacted with the independent variables, producing differential effects on performance. Visual abilities logically grouped into three principal components: active accommodation predicted target detection and identification; passive accommodation predicted detection and acquisition; and image interpretation predicted acquisition, identification, and tracking. Results supported the three visual subsystems hypothesis, based on neurophysiological evidence of pathways in the brain corresponding to specific visual functions.

Author

A90-49065\* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

### NUCLEAR REACTION EFFECTS IN CONVENTIONAL RISK ASSESSMENT FOR ENERGETIC ION EXPOSURE

JOHN W. WILSON, JUDY L. SHINN, and LAWRENCE W. TOWNSEND (NASA, Langley Research Center, Hampton, VA) Health Physics (ISSN 0017-9078), vol. 58, June 1990, p. 749-752. refs

#### Copyright

A volume of tissue through which a monoenergetic ion fluence has passed is considered, and the energy absorbed by the media

in the passage is evaluated. Various contributions to biological risk are quantified using quality factors presently in force. The effects of newly proposed quality factors are evaluated. C.D.

**A90-49066\*** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

#### RISK ASSESSMENT METHODOLOGIES FOR TARGET FRAGMENTS PRODUCED IN HIGH-ENERGY NUCLEON REACTIONS

J. L. SHINN, J. W. WILSON (NASA, Langley Research Center, Hampton, VA), and D. M. NGO (Hampton University, VA) Health Physics (ISSN 0017-9078), vol. 59, July 1990, p. 141-143. refs Copyright

Collisions of energetic protons with target nuclei yield nuclear products of large linear energy transfer, and it is usually assumed that the energy of the heavy products is absorbed locally with a quality factor of 20. Past methods of risk assessment have relied on the Bertini (1969) model to evaluate the nuclear reaction products. If the Q(F) of 20 is correct, then a significant underestimate of biological risk from the nuclear products could result from the use of Bertini's model. On the other hand, a Q(F) of 20 is probably too large for some of the lighter fragments, leaving prior risk estimates as possibly correct or even conservative. This issue is discussed here in the context of the recently proposed nuclear data set of Wilson et al. (1989).

**A90-49276\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

### HUMAN EXERCISE CAPABILITIES IN SPACE

JOHN E. GREENLEAF (NASA, Ames Research Center, Moffett Field, CA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 13 p. refs (SAE PAPER 901200) Copyright

Maintenance of rest and exercise performance are prime requirements for all astronauts during flight, not only for maintaining day-to-day productivity, but also for coping with unlikely emergencies. Indirect estimates of submaximal work capacity (oxygen uptake) made from changes in the heart rates of 27 Apollo astronauts (less than 15-day flights) indicated a reduction in work capacity (maximal oxygen uptake) of 17 to 21 percent. This percentage decrease was similar to that measured in middle-aged men after 21 to 30 days of -6 deg head-down bed-rest deconditioning without exercise training. Heart-rate changes during submaximal exercise in the nine Skylab astronauts suggested that they were better able to maintain their work capacity because of longer and more intensive in-flight exercise training. The strength of the flexor and extensor muscle groups decreased by 2 to 9 percent in the elbow and by 6 to 20 percent in the knee in the Skylab astronauts, also similar to the decreases in men undergoing 30 days of bed-rest deconditioning. Exercise protocols have been devised that result in maintenance of work capacity and muscular strength during 30 to 49 days of bed-rest deconditioning. Author

# **A90-49327\*** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

# SPACE STATION FREEDOM CHECS OVERVIEW

JOEY B. BOYCE (NASA, Johnson Space Center, Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 11 p. refs (SAE PAPER 901258) Copyright

The current status, progress, and future plans for development of the Crew Health Care System (CHeCS) for the International Space Station Freedom are presented. Essential operational biomedical support requirements for the astronauts, including medical care, environmental habitat monitoring, and countermeasures for the potentially maladaptive physiological effects of space flight will be provided by the CHeCS. Three integral parts will make up the system: a health maintenance facility, an environmental health system, and the exercise countermeasures facility. Details of each of the major systems and their subsystems are presented. R.E.P. A90-49328\* Krug International, Houston, TX.

# SPACE STATION REQUIREMENTS FOR IN-FLIGHT EXERCISE COUNTERMEASURES

JUDITH C. HAYES (Krug International, Houston, TX) and BERNARD A. HARRIS (NASA, Johnson Space Center, Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 7 p. refs (SAE PAPER 901259) Copyright

In an effort to retard the deleterious effects of space adaptation, NASA has defined requirements for an Exercise Countermeasure Facility (ECF) within the Space Station Crew Health Care System (CHeCS). The application of exercise as a countermeasure to spaceflight-induced deconditioning has been utilized in the past by both the United States and the Soviet space programs. The ECF will provide exercise hardware, physiological monitoring capabilities, and an interactive motivational display system. ECF operations and data will be coupled through the Space Station Freedom Data Management System for monitoring of inflight training and testing from ground control, thus allowing for real-time evaluation of crewmember performance and modification of exercise prescriptions. Finally, the objective of the ECF is to monitor and control the exercise of crewmembers for the maintenance of

Author

### A90-49329\* Krug International, Houston, TX. DEVELOPMENT OF THE SPACE STATION FREEDOM ENVIRONMENTAL HEALTH SYSTEM

an operational level of fitness to ensure mission success.

ELIZABETH E. RICHARD (Krug International, Technology Life Sciences Div., Houston, TX) and DANE RUSSO (NASA, Johnson Space Center, Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 7 p. refs

(SAE PAPER 901260) Copyright

The Environmental Health System (EHS), a subsystem of the Space Station Freedom (SSF) Crew Health Care System, was established to ensure that crewmembers will have a safe and healthy environment in which to live and work. EHS is comprised of six subsystems: Microbiology, Toxicology, Water Quality, Radiological Health, Vibroacoustics, and Barothermal Physiology. Each subsystem contributes to the overall functions of the EHS including environmental planning, environmental monitoring, environmental monitoring, environmental health assessments, and operations support. The EHS will provide hardware for monitoring the air, water, and internal surfaces of Freedom, including capabilities for inflight sample collection, processing, and analysis. The closed environment of SSF, and its dependence on recycled air and water, will necessitate a reliable monitoring system to alert crewmembers if contamination levels exceed the maximum allowable limits established to ensure crew health and safety. This paper describes the functions and hardware design status of the EHS. Author

#### A90-49331

CLINICAL LABORATORY DIAGNOSIS FOR SPACE MEDICINE BRUCE A. MCKINLEY (Krug International, Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 10 p. refs (SAE PAPER 901263) Copyright

A clinical laboratory system, based on commercially available devices or technologies, is being designed for Space Station Freedom. This system will be used by the crew medical officer to provide analysis of discrete samples of blood and other biological fluids. Clinical chemistry, blood gas analysis, hematology, and microbiology are planned to be available at the Space Station as components of the Crew Health Care System. As with many space systems, ease of use, compact size, and reliability are primary guidelines. An experimental clinical chemistry analyzer was built for the Space Station Freedom medical care facility, and is being tested in selected clinical settings that may be similar to those that will be encountered at a space station, planetary outpost, or transfer vehicle.

#### A90-49363 DESIGN AND EVALUATION OF AN ELECTRONIC STETHOSCOPE SYSTEM FOR THE SPACE STATION FREEDOM HMF

JOHN GOSBEE (Krug International Corp., Houston, TX) SAE. Intersociety Conference on Environmental Systems, 20th. Williamsburg, VA, July 9-12, 1990. 6 p. refs (SAE PAPER 901323) Copyright

With an electronic stethoscope system, the Space Station Freedom Health Maintenance Facility will have the capability to electronically acquire, store, and transmit lung, heart, and bowel sounds to earth. This electronic stethoscope system will aid in clinical diagnosis, treatment, and monitoring functions. To evaluate these clinically relevant performance requirements, both subjective and objective test plans have been conceived. These test plans as well as preliminary results are discussed. Author

#### A90-49364

#### STERILE WATER FOR INJECTION SYSTEM FOR ON-SITE PRODUCTION OF IV FLUIDS AT SPACE STATION FREEDOM HMF

BRUCE A. MCKINLEY (Krug International Corp., Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 19 p. refs (SAE PAPER 901324) Copyright

Space Station Freedom's Health Maintenance Facility (HMF) will have extremely limited storage space; the fluids for intravenous administration of drugs to crewmember must accordingly be prepared from potable water. The Sterile Water for Injection System (SWIS) Medical Development Unit devised to meet these requirements is based on passive disposable water purification cartridges, bacterial filters, and water containers. Solute or concentrate drugs are added to the sterile water to formulate the desired fluids. Preliminary test results from the SWIS prototype involving removal of ionic, organic, endotoxic, and microbial contaminants' removal have indicated considerable system reliability, despite the use of test solutions with contaminant contents far in excess of those envisioned in the HMF potable water supply. O.C.

#### A90-49365

#### FORMULATION, PREPARATION AND DELIVERY OF PARENTERAL FLUIDS FOR THE SPACE STATION FREEDOM HEALTH MAINTENANCE FACILITY

GERALD J. CREAGER (Krug International Corp., Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 12 p.

### (SAE PAPER 901325) Copyright

Investigations were conducted to develop a system for preparation of solutions on-orbit for medical use. Fluid protection hardware was developed and evaluated to determine its suitability for producing sterile water for injection, and parenteral solutions as described in the United States Pharmacopia, vol. XXI. Testing was designed to determine the limits of the devices and laboratory evaluations of candidate intravenous infusion pumps were undertaken to characterize the devices. Fluid formulation in microgravity and delivery of the parental solutions are discussed. Design and testing procedures of the system are outlined and initial characterizations of the sterile water production hardware indicate its ability to function beyond the desired design limits. L.K.S.

#### A90-49366

#### MEDICAL CONCERNS FOR ASSURED CREW RETURN VEHICLE FROM SPACE STATION FREEDOM

SAE, DEBRA L. KRUPA (Krug International Corp., Houston, TX) Intersociety Conference on Environmental Systems, 20th. Williamsburg, VA, July 9-12, 1990. 11 p. refs

(SAE PAPER 901326) Copyright

The Assured Crew Return Vehicle (ACRV) system was created as a means of return or rescue of the crew from SSF in case the Space Shuttle becomes unavailable. Designed to perform as a lifeboat on a single mission, the vehicle has to be dependable while operated by a wide range of limited training personnel and to do the return safely. In case of illness or injury due to prolonged space exposure, the resulting inability of the crew to perform efficiently required an overall simplicity in operation. The development of suitable software and flight control systems, with few manual operations, help to achieve these goals. The vehicle has to be constantly available and the entire system reliable and affordable. Three emergency situations are singled out as most important for design purposes. The effects of acceleration on a deconditioned crewmember during the return flight, transport logistics and some related medical aspects are discussed in detail. ΒP

#### A90-49367

#### **MEDICAL INFORMATION BUS - INTEGRATED MONITORING** FOR THE HMF OF SPACE STATION FREEDOM

WELDON L. WHITE (Krug International Corp., Houston, TX) SAE. Intersociety Conference on Environmental Systems, Williamsburg, VA, July 9-12, 1990. 12 p. 20th,

(SAE PAPER 901328) Copyright

The features of a medical device (MD) communications standard, currently in development, are described and subsequent solutions to many of the MD data acquisition problems are illustrated. The P1073 Medical Information Bus (MIB) features a standardized MD data language which establishes a communication link between the host computer and any MIB medical device regardless of device type. It is projected that MIB will be able to provide the Space Station Freedom (SSF) health maintenance facility medical devices with standard hardware and software interfaces to connect to the medical decision support system (MDSS). A standardized interface on each of the medical devices located in the SSF crew health care system facilities will enable the MDSS to recognize and acquire data from each of these instruments regardless of the facility to which it is connected.

L.K.S.

#### A90-49377

### ASTRONAUT EXPOSURE TO SPACE RADIATION - SPACE SHUTTLE EXPERIENCE

WILLIAM ATWELL (Rockwell International Corp., Space Transportation Systems Div., Houston, TX) SAE. Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 11 p. refs

(SAE PAPER 901342) Copyright

Space Shuttle astronauts are exposed to both the 'trapped' radiation and the galactic cosmic radiation environments. In addition, the sun periodically emits high-energy particles which could pose a serious threat to flight crews. NASA adheres to federal regulations and recommended exposure limits for radiation protection and has established a radiological health and risk assessment program. Using models of the space radiation environment, a Shuttle shielding model, and an anatomical human model, crew exposure estimates are made for each Shuttle flight. The various models are reviewed. Dosimeters are worn by each astronaut and are flown at several fixed locations to obtain inflight measurements. The dosimetry complement is discussed in detail. A comparison between the premission calculations and measurements is presented. Extrapolation of Shuttle experience to long-duration exposure is explored. Author

#### A90-49379

#### RECENT DEVELOPMENTS IN ESTIMATES OF CANCER RISK FROM IONIZING RADIATION

WARREN K. SINCLAIR (National Council on Radiation Protection and Measurements, Bethesda, MD) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 6 p. refs

(SAE PAPER 901344) Copyright

The probability of cancer induction is the main concern in the exposure of individuals to low doses of ionizing radiation. Estimates of the risk of cancer induction, formerly (1977-1980) about 0.001/Sv have recently been increased to 0.003-0.005/Sv for low doses. These increased estimates are mainly the result of changes in

# 52 AEROSPACE MEDICINE

the assessment of the Japanese survivors of the A-bombs in 1945. They result from the accumulation of 11 years or more of data on solid tumors, changes in the statistical projection methods and revisions in the dosimetry of those exposed. The dosimetry revisions are the result of a very comprehensive U.S.-Japan study which defines the doses more precisely than before. The high dose/high dose rate exposures in Japan result in risks higher than those due to low doses/dose rates. Thus, these risks must be reduced by a dose-rate effectiveness factor, which is derived mainly from laboratory information. These changes in cancer risk estimates will impact on NCRP and ICRP recommendations on protection limits for low-LET radiation. For high-LET radiations such as those encountered in space the risks are known relative to low-LET radiation effects therefore a quality factor must be applied, which introduces additional uncertainty. Author

A90-49381\* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

DEEP-SPACE RADIATION EXPOSURE ANALYSIS FOR SOLAR CYCLE XXI (1975-1986)

JOHN E. NEALY, LISA C. SIMONSEN, LAWRENCE W. TOWNSEND, and JOHN W. WILSON (NASA, Langley Research Center, Hampton, VA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 10 p. refs (SAE PAPER 901347) Copyright

Ionizing radiation exposures and associated dosimetric quantities are evaluated for the 11-year solar cycle ending in 1986. Solar flare fluences for the 55 largest flares occurring during the cycle are superimposed on the Galactic cosmic ray flux. Published summaries of flare data from the Interplanetary Monitoring Platform (IMP)-7 and IMP-8 satellites are used that include flares whose integrated fluences are greater than 10 to the 7th protons/sg cm for energies in excess of 10 MeV. A standard cosmic ray environment model for ion flux values at solar minimum and maximum is invoked with an assumed sinusoidal variation between the lower and upper limits. The radiation shielding analysis is carried out for equivalent water-shield thicknesses between 2 and 15 g/sq cm. Results are expressed in terms of cumulative incurred dose equivalents for deep-space missions lasting between 3 months and 3 years. It was found that medium-to-large flare contributions are of greatest importance for the shorter term missions, while the Galactic component dominates for the longer duration Author missions.

#### A90-49392\* Krug International, Houston, TX. COMPUTER SIMULATION OF CARDIOVASCULAR CHANGES DURING EXTENDED DURATION SPACE FLIGHTS

R. SRINI SRINIVASAN (Krug Life Sciences, Inc., Houston, TX), JOHN B. CHARLES (NASA, Johnson Space Center, Houston, TX), and JOEL I. LEONARD (Lockheed Engineering and Sciences Co., Washington, DC) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 14 p. refs

(SAE PAPER 901359) Copyright The application of mathematical modeling and computer simulation to the study of spaceflight cardiovascular changes is examined using a multicompartment representation model of the entire human cardiovascular system including its control elements. The model simulates the beat-to-beat dynamic responses of the cardiovascular system to orthostatic stresses. Simulation results pertaining to long-term space flight, the combined effect of +G(z)and blood volume loss, and the effect of anti-G suit inflation are discussed, including past results on the original version of the model which has been used in a number of analysis applications at NASA. New results pertain to analysis of cardiovascular changes in extended duration space flights and demonstrate the use of this model in evaluation of physiological factors that contribute to orthostatic intolerance following an exposure to weightlessness, in particular, blood volume loss and changes in the sensitivity of baroreceptors. L.K.S.

#### N90-27244\*# Analytics, Inc., Willow Grove, PA. COCKPIT OCULAR RECORDING SYSTEM (CORS) Final Report

EDWARD ROTHENHEBER, JAMES STOKES. CHARLES. LAGROSSA, WILLIAM ARNOLD, and A. O. DICK Washington NASA Mar. 1990 104 p

(Contract NAS1-18473)

(NASA-CR-4281; NAS 1.26:4281; TR-2107) Avail: NTIS HC A06/MF A01 CSCL 06/16

The overall goal was the development of a Cockpit Ocular Recording System (CORS). Four tasks were used: (1) the development of the system; (2) the experimentation and improvement of the system; (3) demonstrations of the working system; and (4) system documentation. Overall, the prototype represents a workable and flexibly designed CORS system. For the most part, the hardware use for the prototype system is off-the-shelf. All of the following software was developed specifically: (1) setup software that the user specifies the cockpit configuration and identifies possible areas in which the pilot will look; (2) sensing software which integrates the 60 Hz data from the oculometer and heat orientation sensing unit; (3) processing software which applies a spatiotemporal filter to the lookpoint data to determine fixation/dwell positions; (4) data recording output routines; and (5) playback software which allows the user to retrieve and analyze the data. Several experiments were performed to verify the system accuracy and quantify system deficiencies. These tests resulted in recommendations for any future system that might be constructed. Author

N90-27245# Illinois Univ., Savoy.

THE INTEGRATION OF COMPLEX INFORMATION FROM AUDITORY AND VISUAL CHANNELS UNDER STRESS Final Report

CHRISTOPHER D. WICKENS May 1990 19 p (Contract DA PROJ. 1L1-61102-B7-4A) (AD-A222686; HEL-TN-5-90) Avail: NTIS HC A03/MF A01 CSCL 06/10

Research that was performed at the University of Illinois Aviation Research Laboratory is described. This research examined how the human operator's ability to integrate multiple channels of information is influenced by stress and by display formatting which brings channels of information closer. In a series of experiments, it was concluded that information integration is facilitated by combining formation channels into a single object display and by the use of common color. These manipulations do not necessarily facilitate dual task performance or focused attention. Some important distinctions in the creation of object displays are also described. It was also concluded that the use of common perceptual modalities (all visual) or spatial proximity does not enhance information integration ability relative to dual task performance. The use of a single hand to perform two integrated response actions can facilitate performance, particularly if one action is continuous and the other is discrete. In some studies, the effects of mild stressors were imposed to enhance benefits associated with multi-task auditory displays and to enhance the benefits of object displays. GRA

N90-27246# Environmental Protection Agency, Research Triangle Park, NC, Human Studies Div.

NEUROBEHAVIORAL EFFECTS OF CARBON MONOXIDE (CO) EXPOSURE IN HUMANS: ELEVATED CARBOXYHEMOGLOBIN (COHB) AND CEREBROVASCULAR RESPONSES Final Report, 1985 - 1989

VERNON A. BENIGNUS, MATTHEW L. PETROVICK, and JAMES D. PRAH (North Carolina Univ., Chapel Hill.) 19 May 1989 58 p

(Contract DA PROJ. 3E1-62777-A-878)

(AD-A222840) Avail: NTIS HC A04/MF A01 CSCL 06/14

A two-channel cranial impedance plethysmography (CIP) was designed and constructed as a noninvasive measure of brain blood flow (BBF) in man. The instrument was designed to reduce some of the problems with instability and difficulty of use found in earlier commercially-available models. The CIP was previously validated against other measures of BBF. During carboxylhemoglobin (COHb) formation, BBF is known to increase. When BBF increases it compensates for the reduced ability of the blood to carry oxygen in the presence of COHb. Fifteen men breathed carbon monoxide to produce increases in COHb values range from endogenous 18.4 percent. GRA

#### N90-27247# Naval Medical Research Inst., Bethesda, MD. WORK ENHANCEMENT AND THERMAL CHANGES DURING INTERMITTENT WORK IN COOL WATER AFTER CARBOHYDRATE LOADING Technical Report, Feb. - May 1988

J. W. THORP, K. D. MITTLEMAN, K. J. HABERMAN, J. F. HOUSE, and T. J. DOUBT Mar. 1990 36 p

(AD-A222877; NMRI-90-14) Avail: NTIS HC A03/MF A01 CSCL 06/1

The effect was evaluated of carbohydrate loading (TEST) vs control diet (CON) on the thermal status and the ability of 8 U.S. Navy divers to perform intermittent leg exercise at 80 percent max Oxygen 2 consumption during head-out immersion in 25 C water. Each subject was tested once after 3 days of the TEST diet (600 grams carbohydrate/day) and once after 3 days of CON diet (less than 300 g carbohydrate/d). The TEST diet included 200 to 400 grams of glucose polymer solution (GPS). Both diets were nutritionally complete and provided 3000 Kcal/d. A pattern of 10 min rest/20 min work was repeated until the diver could no longer complete a 20-min work session or until 8 sessions had been completed. Divers completed more work after TEST than CON. Four completed all 8 work sessions after both diets; 3 completed all sessions after TEST, but not CON; one completed 7 sessions after TEST and 6 after CON. Differences between diets for O2 consumption, CO2 production, and minute ventilation were not significant. GRA

# N90-27248# Pacific-Sierra Research Corp., Los Angeles, CA. EFFECTS OF IONIZING RADIATION ON THE PERFORMANCE **OF SELECTED TACTICAL COMBAT CREWS Technical**

Report, 12 Mar. 1986 - 30 Oct. 1987 M. A. DORE and G. H. ANNO 1 May 1 May 1990 138 p (Contract DNA001-85-C-0352)

(AD-A222880; PSR-1846; DNA-TR-88-173) Avail: NTIS HC A07/MF A01 CSCL 06/4

A general model is developed for characterizing the expected performance of four selected types of tactical army combat crews when the individual crewmembers function at degraded performance levels due to acute exposure to ionizing radiation. The model is also applicable to other situations that degrade individual crewmember performance. The results provide performance data for larger scale U.S. Army models that simulate battlefield conflicts where nuclear weapons might be employed. Performance-level data are generated as a function of dose and time after exposure for each crew type. GRA

N90-27249# McGill Univ., Montreal (Quebec). Computer Vision and Robotics Lab.

#### CURVATURE ESTIMATION IN ORIENTATION SELECTION Annual Technical Report, 1 Feb. 1989 - 31 Jan. 1990

STEVEN W. ZUCKER and MAX S. CYNADER (British Columbia Univ., Vancouver.) 29 Mar. 1990 5 p

(Contract AF-AFOSR-0260-89; AF PROJ. 2313)

(AD-A221481; AFOSR-90-0422TR) Avail: NTIS HC A01/MF A01 CSCL 06/4

This research effort is concentrated on the computational neuroscience of early vision. Progress was made on the following problems: (1) a model of end-stopped visual cortical neurons was extended to include complex components; (2) an extensive simulation of the model was completed with regard to orientation, positional, spatial frequency, curvature, chevron, and end-line sensitivity; (3) orientation discontinuities were extended into the motion domain, and psychophysical and computational experiments confirm the hypothesis of multiple directions being represented at a point of discontinuity; and (4) the mathematical foundations were laid for a theory of shape. GRA

N90-27250# Massachusetts Univ., Worcester. Dept. of Neurology.

NON-LINEAR ANALYSIS OF VISUAL CORTICAL NEURONS Annual Report No. 1, 1 Jan. - 31 Oct. 1989

LOWELL D. JACOBSON, JAMES P. GASKA, and DANIEL A. POLLEN 12 Mar. 1990 7, p (Contract AF-AFOSR-0247-89; AF PROJ. 2313)

(AD-A221543; AFOSR-90-0429TR) Avail: NTIS HC A02/MF A01 CSCL 23/3

New equipment was purchased and set up and new software was developed in preparation for electrophysiological experiments to study the neural networks that underly the binocular non-linear filtering properties of cells in the monkey (Macaca fascicularis) visual cortex. This preparatory task was completed. In addition, new methods were developed for using input-output measurements to identify multi-input nonlinear systems. In addition, the new system identification methods were applied in preliminary analyses of previously obtained monocular stimulus-response data. GRA

Harvard Univ., Cambridge, MA. Div. of Applied N90-27251# Sciences.

THE EFFECTS OF LUMINANCE BOUNDARIES ON COLOR PERCEPTION Annual Technical Report, 15 Mar. 1989 - 14 Mar. 1990

RICHARD E. KRONAUER, R. T. ESKEW, JR., and C. F. STROMEYER, III 12 Apr. 1990 16 p

(Contract AF-AFOSR-0304-89; AF PROJ. 2313)

(AD-A221544; AFOSR-90-0419TR) Avail: NTIS HC A03/MF A01 CSCL 20/6

When a suprathreshold luminance flash, presented as an increment on a larger background field, accompanies a circular equiluminant chromatic flash at the same spatial location, the chromatic threshold is reduced by about two-fold. This facilitation results from the clearly-visible edges of the luminance flash (the pedestal) serving to demarcate the test region, segregating it from its surround. Signal detection experiments show that this facilitation does not occur because the contour reduces the spatio-temporal detection uncertainty of the observer. Partial and incomplete luminance contours produce partial facilitation. An illusory contour pattern can produce the full facilitation effect, measured with a forced-choice method. Recent experiments show that a thin luminance line which bisects the test region produces weak facilitation, the amount of which varies slightly with line length. This result poses a challenge to simple models of the facilitation mechanism, since the line does not demarcate two differently colored regions. The facilitation effect can be used as a rigorous means of probing the way in which low level visual attributes (edge, color) interact at higher levels.

N90-27252# Central Inst. for the Deaf, Saint Louis, MO. **BINAURAL MASKING: AN ANALYSIS OF MODELS Annual** Technical Report, 1 Apr. 1989 - 31 Mar. 1990 ROBERT H. GILKEY 30 Apr. 1990 12 p

(Contract AF-AFOSR-0302-89; AF PROJ. 2313)

(AD-A221668; AFOSR-90-0632TR) Avail: NTIS HC A03/MF A01 CSCL 06/4

The ultimate goal is to specify the transformations of the auditory stimulus used by the subject to determine the presence or absence of a signal when masked by an interfering sound, with particular emphasis on the role of processes that compare information in the frequency domain and in the time domain, and on the relation between monaural and binaural processing. Traditional psychophysical procedures are combined with new techniques (molecular psychophysics), which allow the data to be examined in considerably, greater detail. With these techniques, conclusions and theories based on more general analyses are often shown to be inadequate. A number of experiments were conducted to evaluate models of monaural and binaural masking. The responses of subjects to individual noise-alone and signal-plus-noise waveforms could not be predicted based on the energy in a single auditory filter or a linear combination of several auditory filters.

GRA

# 52 AEROSPACE MEDICINE

N90-27253# State Univ. of New York, Plattsburgh. THE EFFECTS OF BLAST TRAUMA (IMPULSE NOISE) ON HEARING: A PARAMETRIC STUDY SOURCE 2 Annual Report No. 3

ROGER P. HAMERNIK, WILLIAM A. AHROON, ROBERT I. DAVIS, KENG D. HSUEH, and GEORGE A. TURRENTINE Dec. 1989 52 p

(Contract DAMD17-86-C-6172; DA PROJ. 3M1-61102-BS-15) (AD-A221731; ARL-90-2) Avail: NTIS HC A04/MF A01 CSCL 06/4

There are three broad goals to this contract. The first and primary goal is to study the effects of high level blast wave exposure on the conductive and sensory structures of the mammalian ear. This includes the use of the auditory evoked potential to measure hearing thresholds and tuning curves prior to and after exposure to various blast wave exposures. Parameters of the blast waves studied include intensity, spectral composition, number of impulses and repetition rate. Correlations among hearing measures, exposure variables and histology have been developed. To achieve the above, the following two objectives must be completed: (1) develop a series of blast wave generation devices which are suitable for the laboratory simulation of a wide spectrum of blast waves; and (2) develop suitable software and a PC-based computer system which will interact with crystal and capacitive microphones to capture and analyze blast waves. Four sources have been developed along with the specified analysis system. The results from the Source I (a conventional shock tube) were summarized in reports ADA 206-180 and ADA 203-854. This report summarizes the results from Source II, a 5-inch Lamont valve-driven shock GRA tube.

N90-28323# Michigan Univ., Ann Arbor. Transportation Research Inst.

# THE MEASUREMENT OF DARK ADAPTATION LEVEL IN THE PRESENCE OF GLARE

PAUL L. OLSON and TOSHIAKI AOKI Nov. 1989 16 p Sponsored by Univ. of Michigan Industry Affiliation Program for Human Factors in Transportation Safety, Ann Arbor, MI (PB90-155987; UMTRI-89-34) Avail: NTIS HC A03/MF A01 CSCL 06/16

An investigation was carried out to measure the effect of glare on driver dark adaptation. The procedure used was to measure the time after the glare was extinguished until the subject could detect a target light source. The procedure was calibrated in a laboratory by adapting the subject to a large surface of known luminance, reducing its luminance to that associated with low beams on a dark road, and measuring the time until the target source could be detected. The test was run facing standard US-type low and high beams at a distance of about 150 feet. The level of dark adaptation was found to be about 4 ft-L with low beams and about 20 ft-L with high beams. Author

**N90-28324**# Paris V Univ. (France). Groupe d'Etude et de Recherche de Physiologie Ambulatoire.

ELECTROCARDIOGRAM OF MILITARY AIRCRAFT PILOTS MEASURED DURING REAL FLIGHT MISSIONS: STUDY OF THE VARIABILITY OF THE CARDIAC RHYTHM IN CORRELATION WITH WORKING STRESS [MESURE DE L'E.C.G. DE PILOTES D'AVION DE COMBAT EN MISSION DE VOL REEL: ETUDE DE LA VARIABILITE DU RYTHME CARDIAQUE ET CORRELATION AVEC LA CHARGE DE TRAVAIL]

1984 106 p In FRENCH (Contract DRET-84-107)

(ETN-90-97453) Avail: NTIS HC A06/MF A01

The success of a mission depends on the working charge the crew can stand. As there are no means of measuring this working charge directly, it is indirectly evaluated by monitoring the variations of the cardiac rhythm of the crew. The investigation was carried out on the pilot and navigator engineer of the Mirage 2000N aircraft. The results show that the cardiac rhythm changes under low height limiting flight conditions. Flight stress analysis of the crew with

and without automatic pilots are carried out. Suggestions for further investigations are provided.

**N90-28325** Institute for Perception RVO-TNO, Soesterberg (Netherlands). Audiology Group.

INFLUENCE OF GRAVITO-INERTIAL FORCE ON VESTIBULAR NYSTAGMUS IN MAN

J. T. MARCUS 19 Jul. 1989 26 p

(Contract A88/M/318) (IZF-1989-24; TD-89-3367; ETN-90-97390) Copyright Avail: Institute for Perception RVO-TNO, P.O. Box 23, 3769 ZG Soesterberg, Netherlands

The influence of high +Gz gravito-inertial force (= G load) on the vestibular system in man was investigated in a centrifuge with a freely swinging gondola. The verticular vestibular nystagmus induced by acceleration to 3 G was analyzed, and compared with reference measurements at 1 G. Results indicate that the effects of increased G load are expressed in a prolonged time constant of the upbeat nystagmus, and in a subject-dependent persisting component of this nystagmus. In an attempt to explain these findings, a current model on the generation of vestibular induced eye movements is extended: angular acceleration stimulates the semicircular canals, which in an existing model induce slow compensatory eye movements via a direct reflex path, as well as through an integrated network in the central vestibular nuclei. This model is extended with the G load as a stimulus function for the otoliths, which are influencing eye movements via a direct path, as well as through a modulating action on the central integrator. This influence of G load on the vestibular system could interfere with visual perception, and thereby play a role in inducing spatial disorientation. **FSA** 

**N90-28326** Institute for Perception RVO-TNO, Soesterberg (Netherlands). Thermophysical Group.

PHYSIOLOGICAL REACTIONS TO HEAT STRESS; QUANTIFYING THE EFFECTS OF INDIVIDUAL PARAMETERS G. HAVENITH and H. VANMIDDENDORP 1 Sep. 1989 39 p (Contract B87-62)

(IZF-1989-30; TD-89-1056; ETN-90-97394) Copyright Avail: Institute for Perception RVO-TNO, P.O. Box 23, 3769 ZG Soeterberg, Netherlands

For the purpose of quantifying the relative influence of individual characteristics for a person's heat strain, 24 subjects were analyzed regarding their individual characteristics and exposed to three climates (21 C, 50 percent RH (Relative Humidity), 34 C, 80 percent RH and 45 C, 20 percent RH) with three work levels (rest. 25. and 45 percent VO2 maximal oxygen uptake). Their psychological responses were recorded and submitted to regression analysis. It was shown that 88 percent of the variance in heat storage could be explained by the climate and metabolism. Of the remaining variance, the percent fat, the surface/mass ratio, VO2 max and sweat rate-rectal temperature gain, explained 33 percent of the remaining variance. Seventy-five percent of the variance in heart rate was explained by metabolism and climate. Of the remaining variance 46 percent was explained by the VO2 max. Ninety-six percent of skin temperature variation was explained by climate and metabolism. Individual parameters add only 0.5 percent to the explained variance. Prediction of rectal temperature, oesophagal temperature, blood pressure and skin bloodflow also improved by the addition of individual characteristics. The explained variance for these variables is too low (less than 70 percent) to use them as strain predictors, however.

**N90-28327\*** National Aeronautics and Space Administration, Washington, DC.

#### AEROSPACE MEDICINE AND BIOLOGY: A CONTINUING BIBLIOGRAPHY WITH INDEXES (SUPPLEMENT 339) Aug. 1989 53 p

(NASA-SP-7011(339); NAS 1.21:7011(339)) Avail: NTIS HC A03; NTIS standing order as PB90-912300, \$11.50 domestic, \$23.00 foreign CSCL 06/5

This bibliography lists 105 reports, articles and other documents introduced into the NASA Scientific and Technical Information

System during July 1990. Subject coverage includes: aerospace medicine and psychology, life support systems and controlled environments, safety equipment, exobiology and extraterrestrial life, and flight crew behavior and performance. Author

# 53

# BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

#### A90-47247

# A NETWORK MODEL OF CATECHOLAMINE EFFECTS - GAIN, SIGNAL-TO-NOISE RATIO, AND BEHAVIOR

DAVID SERVAN-SCHREIBER (Carnegie-Mellon University; Pittsburgh, University, PA), HARRY PRINTZ (Carnegie-Mellon University, Pittsburgh, PA; Digital Equipment Corp., Paris Research Laboratory, Rueil-Malmaison, France), and JONATHAN D. COHEN (Carnegie-Mellon University; Pittsburgh, University, PA; Stanford University, CA) Science (ISSN 0036-8075), vol. 249, Aug. 24, 1990, p. 892-895. refs

(Contract NIH-MH-09696; NIH-MH-00673; N00039-87-C-0251; ARPA ORDER 4864)

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At the level of individual neurons, catecholamine release increases the responsivity of cells to excitatory and inhibitory inputs. A model of catecholamine effects in a network of neural-like elements is presented, which shows that (1) changes in the responsivity of individual elements do not affect their ability to detect a signal and ignore noise but (2) the same changes in cell responsivity in a network of such elements do improve the signal detection performance of the network as a whole. The second result is used in a computer simulation based on principles of parallel distributed processing to account for the effect of central nervous system stimulants on the signal detection performance of human subjects.

#### A90-47500

### INTERNAL REPRESENTATION, INTERNAL MODEL, HUMAN PERFORMANCE MODEL AND MENTAL WORKLOAD

HENK G. STASSEN (Delft, Technische Universiteit, Netherlands), GUNNAR JOHANNSEN (Kassel, Gesamthochschule, Federal Republic of Germany), and NEVILLE MORAY (Illinois, University, Urbana) Automatica (ISSN 0005-1098), vol. 26, July 1990, p. 811-820. refs

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In supervising complex industrial processes, the human supervisor has to reach a certain performance while not exceeding the mental capacity he is willing to spend. A well-designed human-machine-interface can help the supervisor to achieve these goals. A well-proven method of designing such systems is to model system behavior, thus modeling human performance and mental load. This paper reviews the literature in the field of human-machine systems, with special emphases on human operator models and mental load measures. The review is presented in terms of Rasmussen's (1983 and 1986) three-level model and integrates the various articles in some well defined concepts.

### A90-49039\* Georgia State Univ., Atlanta.

### EFFECTS OF COMPETITION ON VIDEO-TASK PERFORMANCE IN MONKEYS (MACACA MULATTA)

DAVID A. WASHBURN, WILLIAM D. HOPKINS, and DUANE M. RUMBAUGH (Georgia State University, Atlanta) Journal of Comparative Psychology (ISSN 0735-7036), vol. 104, no. 2, 1990, p. 115-121. Research supported by the Georgia State University. refs

(Contract NAG2-438; NIH-HD-06016) Copyright

The effects of competition on performance of a video-formatted

task were examined in a series of experiments. Two rhesus monkeys (Macaca mulatta) were trained to manipulate a joystick to shoot at moving targets on a computer screen. The task was made competitive by requiring both animals to shoot at the same target and by rewarding only the animal that hit the target first each trial. The competitive task produced a significant and robust speed-accuracy trade-off in performance. The monkeys hit the target in significantly less time on contested than on uncontested trials. However, they required significantly more shots to hit the target on contested trials in relation to uncontested trials. This effect was unchanged when various schedules of reinforcement were introduced in the uncontested trials. This supports the influence of competition qua competition on performance, a point further bolstered by other findings of behavioral contrast presented here. Author

# A90-49046\* Pittsburgh Univ., PA.

#### NYSTAGMUS RESPONSES IN A GROUP OF NORMAL HUMANS DURING EARTH-HORIZONTAL AXIS ROTATION

CONRAD WALL, III and JOSEPH M. R. FURMAN (Pittsburgh, University, PA) Acta Oto-Laryngologica (ISSN 0001-6489), vol. 108, 1989, p. 327-335. refs

(Contract NH-NS-21819; NIH-NS-00921; NAG9-113) Copyright

Horizontal eye movement responses to earth-horizontal yaw axis rotation were evaluated in 50 normal human subjects who were uniformly distributed in age (20-69 years) and each age group was then divided by gender. Subjects were rotated with eyes open in the dark, using clockwise and counter-clockwise 60 deg velocity trapezoids. The nystagmus slow component velocity is analyzed. It is shown that, despite large intersubject variability, parameters which describe earth-horizontal yaw axis responses are loosely interrelated, and some of them vary significantly with gender and age. L.K.S.

#### A90-49048\* Harvard Medical School, Boston, MA. VISUAL-VESTIBULAR INTERACTION IN HUMANS DURING EARTH-HORIZONTAL AXIS ROTATION

CONRAD WALL, III (Harvard University, Boston, MA) and JOSEPH M. R. FURMAN (Pittsburgh, University, PA) Acta Oto-Laryngologica (ISSN 0001-6489), vol. 109, 1990, p. 753-760. refs

#### (Contract NIH-NS-00921; NIH-NS-21819; NAG9-113) Copyright

Visual-vestibular interaction using 60 percent constant velocity earth horizontal axis yaw rotation, simulating both the horizontal semicircular canals and the otolith organs, was measured in seven human subjects. Subjects were tested with their eyes open in the dark (EOD) while fixating-upon a target rotating with them (FIX), and while observing stationary optokinetic stripes (VVR). Resulting nystagmus slow component velocity (SCV) was analyzed for EOD, FIX, and VVR conditions. It is concluded that the visual-vestibular interactions during EHA differ significantly from those during rotation about the vertical; specifically, there is a nonlinear interaction between linear acceleration and optokinetic nystagmus. L.K.S.

**A90-49062\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

# EFFECT OF CONTRAST ON THE PERCEIVED DIRECTION OF A MOVING PLAID

L. S. STONE, A. B. WATSON, and J. B. MULLIGAN (NASA, Ames Research Center, Moffett Field, CA) Vision Research (ISSN 0042-6989), vol. 30, no. 7, 1990, p. 1049-1067. refs Copyright

A series of experiments examining the effect of contrast on the perception of moving plaids is performed. This was done to test the hypothesis put forth by Adelson and Movshon (1982) that the human visual system determines the direction of a moving plaid in a two-staged process: decomposition into component motion followed by application of the intersection of constraints rule. When the gratings within the plaid are of different contrast, the perceived direction is not predicted by the intersection of constraints rule. There is a strong (up to 20 deg) bias in the direction of the higher-contrast grating. A revised model, which incorporates a contrast-dependent weighting of perceived grating speed as observed for one-dimensional patterns (Thompson, 1982), can quantitatively predict most of the results. Results are discussed in the context of various models of human visual motion processing and of physiological responses of neurons in the primate visual Author system.

A90-49069\* Pittsburgh Univ., PA.

#### EARTH HORIZONTAL AXIS ROTATIONAL RESPONSES IN PATIENTS WITH UNILATERAL PERIPHERAL VESTIBULAR DEFICITS

JOSEPH M. R. FURMAN, DONALD B. KAMERER (Pittsburgh, University, PA), and CONRAD WALL, III Annals of Otology, Rhinology and Laryngology (ISSN 0003-4894), vol. 98, July 1989, p. 551-555. refs

(Contract NIH-NS-00921; NIH-NS-21819; NAG9-113)

Copyright

The vestibulo-ocular reflex (VOR) of five patients with surgically confirmed unilateral peripheral vestibular lesions is evaluated. Testing used both earth vertical axis (EVA) and earth horizontal axis (EHA) yaw rotation. Results indicated that the patients had short VOR time constants, asymmetric responses to both EVA and EHA rotation, and normal EHA modulation components. These findings suggest that unilateral peripheral vestibular loss causes a shortened VOR time constant even with the addition of dynamic otolithic stimulation and causes an asymmetry in semicircular canal-ocular reflexes and one aspect of otolith-ocular reflexes. Author

#### A90-49070\* Massachusetts Eye and Ear Infirmary, Boston. EYES OPEN VERSUS EYES CLOSED - EFFECT ON HUMAN **ROTATIONAL RESPONSES**

CONRAD WALL, III (Massachusetts Eye and Ear Infirmary, Boston) and JOSEPH M. R. FURMAN (Pittsburgh, University, PA) Annals of Otology, Rhinology and Laryngology (ISSN 0003-4894), vol. 98, Aug. 1989, p. 625-629. refs

(Contract NIH-NS-21819; NIH-NS-00921; NAG9-113) Copyright

The effect of eyelid closure on the response to rotational vestibular stimulation was assessed by evaluating 16 normal human subjects with both earth vertical axis (EVA) and earth horizontal axis (EHA) yaw rotations with either eyes closed (EC) or eyes open in the dark (EOD). Results indicated that for EVA rotation, the subjects' responses were of larger magnitude and less variable with EOD than with EC. However, for EHA rotation, responses were of larger magnitude and equally variable with EC as compared to EOD. Data also indicated that the guality of the EHA response with EC was altered because eyelid closure influenced the amount of periodic gaze. It is concluded that eyelid closure has an effect upon both canalocular and otolithocular reflexes and it is suggested that both EVA and EHA rotational testing be performed with EOD rather than with EC. Author

#### A90-49395

#### CREW SELECTION, PRODUCTIVITY AND WELL-BEING FOR HUMAN EXPLORATION MISSIONS

LAUREN B. LEVETON and LYDIA STONE (Lockheed Engineering and Sciences Co., Washington, DC) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 8 p. refs

#### (SAE PAPER 901362) Copyright

Available information from U.S. and Soviet spaceflight experiences is reviewed to aid in selecting crews and maintaining health and productivity for long-duration manned space exploration missions. Factors examined include group selection, cohesion, structure, and leadership. A brief historical review of the astronaut selection process is presented, and information from the Soviet space program is analyzed. NASA Life Sciences strategies and recommendations for addressing these concerns for future space exploration missions are also described. Recommendations include the development of a selection process with emphasis on the selection of groups and use of analogs such as the Antarctic and

undersea habitats to enable researchers to investigate the effects of confinement and isolation on psychological health and group dynamics. It is noted that Antarctic bases provide a testbed for psychological countermeasures, crew selection and training, and performance. L.K.S.

N90-27254# Carnegie-Mellon Univ., Pittsburgh, PA. Artificial Intelligence and Psychology Project.

SYMBOLIC ARCHITECTURES FOR COGNITION Technical Report, 15 Sep. 1986 - 14 Sep. 1991

ALLEN NEWELL, PAUL S. ROSENBLOOM, and JOHN E. LAIRD (Michigan Univ., Ann Arbor.) 1989 Submitted for 42 p publication

(Contract N00014-86-K-0678)

(AD-A222909; AIP-62) Avail: NTIS HC A03/MF A01 CSCL 05/8

This chapter treats the architecture, which is the fixed structure that provides the frame within which cognitive processing in the mind takes place. It describes what an architecture is and how it enters into cognitive theories of the mind. It concentrates on symbolic architectures, the family that includes the architectures central to computer science. It does not treat foundational matters or connectionist architectures. After treating in detail the general requirements of a cognitive architecture, it uses Act and Soar, two architectures relevant to the study of human cognition, to illustrate matters in detail. GRA

N90-27255# Naval Health Research Center, San Diego, CA. THE INTEGRATED AREA MEASURE OF VISUAL

#### ENDOGENOUS ERPS: RELATION TO COGNITIVE WORKLOAD AND HEMISPHERE Final Report -

LEX L. MERRILL and DAVID J. HORD Jun. 1989 23 D Sponsored by Naval Medical Research and Command, Bethesda, MD

(AD-A223191; NHRC-89-25) Avail: NTIS HC A03/MF A01 CSCL 06/4

The Integrated Area Measure (IAM) of event-related brain potentials components was assessed as a simple method of quantifying cognitive workload. Additionally, the hypothesis of Miskin and Appenzeller that the right hemisphere is more involved in visual processing than the left was evaluated. One hundred and two U.S. Navymen were used as subjects and each subject completed a baseline and an oddball visual task. EEG was recorded at two electrode sites (C3 and C4). The results indicate that the IAM may be useful as a measure of cognitive workload. The IAM showed that stimulus discrimination was not greater for the right hemisphere; therefore, the hypothesis of Miskin and Appenzeller was not supported. However, the IAM for the right hemisphere was significantly larger than the left hemisphere measure for discrimination memory. The present data may suggest that the right hemisphere generates the required activity for the updating of working memory. The IAM may ultimately prove to be a useful tool for monitoring the cognitive activity of personnel. GRA

#### N90-27256# Naval Health Research Center, San Diego, CA. **MELATONIN, LIGHT AND, CIRCADIAN CYCLES Interim** Report

TAMSIN LISA KELLY, DEBORAH SMITH, and PAUL NAITOH 25 Dec. 1989 61 p Sponsored by Naval Medical Research and Development Command, Bethesda, MD

(AD-A223196; NHRC-89-38) Avail: NTIS HC A04/MF A01 CSCL 06/5

The body's circadian rhythms affect many aspects of human psychology, physiology, and performance. Melatonin, a hormone secreted by the pineal, is an important element of human circadian rhythmicity. Melatonin is normally at a low level during the day, with a pulse of secretion at night. The timing of melatonin secretion is controlled by the suprachiasmatic nuclei of the hypothalamus. The neuronal pathways which mediate this control are discussed. Light exposure is the main factor which adjusts the hypothalamic clock that controls melatonin release. Melatonin is altered in many disease states. It interacts with other endocrine systems. It probably plays a role in jet lag. Various drugs, including many that are

commonly used and are likely to be taken by military personnel. can affect the melatonin system at different levels: by shifting the hypothalamic clock which controls melatonin release; by directly suppressing release at the level of the pineal, without altering the underlying rhythm; or by altering or blocking the effects of melatonin after it has been released. GRA

N90-27257# Air Force Human Resources Lab., Brooks AFB, TX. Manpower and Personnel Div.

**CROSS-VALIDATION OF EXPERIMENTAL USAF PILOT** TRAINING PERFORMANCE MODELS Interim Report, Jul. 1986 - Aug. 1989

THOMAS R. CARRETTA May 1990 12 p

(Contract AF PROJ. 7719)

(AD-A222253; AFHRL-TR-89-68) Avail: NTIS HC A03/MF A01 CSCL 05/9

A series of studies have indicated that individual differences in hand-eye coordination, information processing ability, personality and attitudes are related to USAF pilot training performance. The current investigation was designed to cross-validate these results. Eight hundred eighty five (885) USAF Undergraduate Pilot Training (UPT) students were divided randomly into two groups. Pilot selection models that used a combination of Air Force Officer Qualifying Test (AFOQT) and Basic Attributes Test (BAT) battery scores were developed independently for each group and then cross-validated with the other group. In the model development phase, subjects with good hand-eye coordination who made quick decisions were more likely to complete UPT successfully in both groups. Although there was some reduction in the validity coefficients in the cross-validation phase, the selection models were related significantly to UPT final outcome in both groups. These results suggest that the AFOQT/BAT pilot selection models are sufficiently robust to be used as adjuncts to operational USAF pilot trainee selection procedures. GRA

N90-27258# Naval Personnel Research and Development Center, San Diego, CA.

#### **REAL-TIME MEASUREMENT OF MENTAL WORKLOAD USING PSYCHOPHYSIOLOGICAL MEASURES Interim Report, Jan. -**Dec. 1989

DARRYL HUMPHREY, ERIK SIREVAAG, ARTHUR F. KRAMER, and AXEL MECKLINGER (Technische Univ., Berlin, Germany, F.R.) Apr. 1990 21 p Presented at the 3rd Annual Workshop on Space Operations, Automation, and Robotics, Houston, TX, 1989; sponsored by ONR Sponsored by Office of Naval Technology, Arlington, VA

(AD-A221462; NPRDC-TN-90-18) Avail: NTIS HC A03/MF A01 CSCL 05/8

The primary goal of the research was to explore the utility of event-related potentials (ERPs) as real-time measures of mental workload. Subjects performed a six-gauge monitoring task and a mental arithmetic task concurrently and at several difficulty levels. Difficulty was varied in terms of gauge predictability and by using two or three column arithmetic problems. A bootstrapping approach was adopted in which 1,000 samples of n trials (n=1,3,5,...65 single trials) were classified as to mental workload level using ERP measures (P300 and slow wave amplitude). Classification accuracies of 85 percent were achieved with 25 trials. Results are discussed in terms of potential enhancements for real-time recording of performance monitoring. GRA

N90-27259# Dayton Univ., OH. Research Inst. AUTOMATIC INFORMATION PROCESSING AND HIGH PERFORMANCE SKILLS: APPLICATION TO TRAINING Interim Technical Report, Aug. 1988 - Oct. 1989

F. THOMAS EGGEMEIER, ANDREA B. GRANITZ, TIMOTHY E. ROGUS, and ERIC E. GEISELMAN Apr. 1990 114 p (Contract F33615-88-C-0015)

(AD-A221709; AFHRL-TR-89-70) Avail: NTIS HC A06/MF A01 CSCL 05/6

This report documents a laboratory research effort to investigate the application of automatic processing theory to analogs of complex command and control (C2) operator tasks. Six experiments were performed to investigate complex skill acquisition and transfer of training. The results indicate that elements of automatic processing theory can be applied to training complex task analogs, and suggest that transfer of this training is relatively unaffected by certain changes in the presentation format of investigation. GRA

N90-27260# Georgia Inst. of Tech., Atlanta. School of Psychology.

AUTOMATIC INFORMATION PROCESSING AND HIGH PERFORMANCE SKILLS: ACQUISITION, TRANSFER, AND **RETENTION Interim Technical Report, Aug. 1988 - Oct. 1989** ARTHUR D. FISK, KEVIN A. HODGE, MARK D. LEE, and WENDY A. ROGERS Apr. 1990 145 p

(Contract F33615-88-C-0015)

(AD-A221744; AFHRL-TR-89-69) Avail: NTIS HC A07/MF A01 CSCL 05/2

Ten experiments involving basic laboratory research on automatic processing theory and skill acquisition are reviewed. The experiments were conducted to investigate the following issues: effects of modified practice, transfer of training, skill decay, and retention. The results of this work provide an understanding of skill acquisition, retention, and transfer with respect to high performance skills training. GRA

N90-28328# Duke Univ., Durham, NC, Dept. of Psychology, CONFERENCE ON THE PERCEPTION OF STRUCTURE PROGRAM AND ABSTRACTS Final Report, 1 Apr. 1989 - 31 Mar. 1990

GREGORY R. LOCKHEAD and JAMES POMERANTZ 1 Jun. 1990 9 p Conference held in New Haven, CT, 22-23 May 1989; sponsored in part by AF, APA, Duke Univ., NIMH, Navy, Rice Univ. and Yale Univ. Submitted for publication (Contract N00014-89-J-1888)

(AD-A222437; REPT-90-01) Avail: NTIS HC A02/MF A01 CSCL 05/8

Honoring Wendell R. Garner, this conference on the Perception of Structure shows how judgments and cognitions depend on the possibilities of the situation. Topics examined include aesthetics, representation in animals and humans, attention, color, integrality, language, imagery, perceptual organization, process models, self-organizing systems, theory, randomness, and retrieval. GRA

National Aeronautics and Space Administration. N90-28329\*# Ames Research Center, Moffett Field, CA.

THE EFFECTS OF TRAINING ON ERRORS OF PERCEIVED DIRECTION IN PERSPECTIVE DISPLAYS

GREGORY K. THARP and STEPHEN R. ELLIS Jul. 1990 26 p

(Contract NCC-86)

(NASA-TM-102792; A-90081; NAS 1.15:102792) Avail: NTIS HC A03/MF A01 CSCL 05/9

An experiment was conducted to determine the effects of training on the characteristic direction errors that are observed when subjects estimate exocentric directions on perspective displays. Changes in five subjects' perceptual errors were measured during a training procedure designed to eliminate the error. The training was provided by displaying to each subject both the sign and the direction of his judgment error. The feedback provided by the error display was found to decrease but not eliminate the error. A lookup table model of the source of the error was developed in which the judgement errors were attributed to overestimates of both the pitch and the yaw of the viewing direction used to produce the perspective projection. The model predicts the quantitative characteristics of the data somewhat better than previous models did. A mechanism is proposed for the observed learning, and further tests of the model are suggested. Author

# 54

# MAN/SYSTEM TECHNOLOGY AND LIFE'

Includes human engineering; biotechnology; and space suits and protective clothing.

#### A90-46399\* General Electric Co., Schenectady, NY. THE KINEMATICS AND DYNAMICS OF SPACE MANIPULATORS - THE VIRTUAL MANIPULATOR APPROACH

Z. VAFA (General Electric Co., Schenectady, NY) and S. DUBOWSKY (MIT, Cambridge, MA) International Journal of Robotics Research (ISSN 0278-3649), vol. 9, Aug. 1990, p. 3-21. refs

(Contract NAG1-801)

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Future robotic manipulator systems will be required to perform complex tasks in space such as satellite repair. These robotic manipulators will encounter a number of kinematic, dynamic, and control problems caused by the dynamic coupling between the manipulators and its spacecraft. This dynamic coupling also makes it difficult to analyze these systems. This paper introduces a new analytical modeling method for space manipulators called the Virtual Manipulator (VM), which has a fixed based in inertial space at a point called a Virtual Ground. The kinematics and dynamics of the manipulator, spacecraft, and payload can be described relatively easily in terms of the VM. With its fixed base, the Virtual Manipulator is shown to have the potential to be an effective aid for the analysis, design, and development of future space manipulator systems.

#### A90-46400

#### THREE-DIMENSIONAL CAMERA SPACE MANIPULATION

S. B. SKAAR, W. H. BROCKMAN, and W. S. JANG (lowa State University, Ames) International Journal of Robotics Research (ISSN 0278-3649), vol. 9, Aug. 1990, p. 22-39. refs (Contract N00014-87-K-0275; N00014-89-J-1533) Copyright

This article extends to three-dimensional tasks the method of camera space manipulation. A minimum of two cameras is required to place points on end effectors (or objects in their grasp) of n-degree-of-freedom manipulators relative to other bodies. This is accomplished using a sequential estimation scheme that permits placement of these points in each of the two-dimensional image planes of monitoring cameras. A precise and robust manipulation strategy that is compatible with 'real time' results. Simulations are used that show the method to be insensitive to two particular kinds of model error - unmodeled elastic deflection and unmodeled camera distortion. The method is tested experimentally with a three-dimensional point placement task. It is then generalized to rigid body placement tasks and illustrated with experiments involving the positioning of one rigid body on a second. An appendix details the unfolding of one such experimental maneuver at several junctures in the visual data-collecting process. Author

### A90-46827

### TRAJECTORY PLANNING FOR A SPACE MANIPULATOR

KATSUHIKO YAMADA and KAZUO TSUCHIYA (Mitsubishi Electric Corp., Mechanics and Technology Dept., Amagasaki, Japan) IN: Astrodynamics 1989; Proceedings of the AAS/AIAA Astrodynamics Conference, Stowe, VT, Aug. 7-10, 1989. Part 2. San Diego, CA, Univelt, Inc., 1990, p. 1265-1281. refs

(AAS PAPER 89-440) Copyright

Trajectory planning of a manipulator mounted on a satellite is considered. The trajectory is designed in order to suppress the attitude variation of the satellite caused by the manipulator motion. A simple time trajectory of the manipulator hand in the work space is obtained from a simplified satellite model. This trajectory is applied to a satellite model with a 6-DOF manipulator, and compared with the trajectory obtained by the numerical calculation to minimize a cost function. The result shows that the proposed trajectory is similar to the optimal trajectory and can suppress the attitude variation of the satellite. Author

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A90-47651\*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

# ON DYNAMICS AND CONTROL OF MULTI-LINK FLEXIBLE SPACE MANIPULATORS

W. GAWRONSKI, C.-H. C. IH, and S. J. WANG (JPL, Pasadena, CA) IN: AIAA Guidance, Navigation and Control Conference, Portland, OR, Aug. 20-22, 1990, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 725-734. refs

(AIAA PAPER 90-3396) Copyright

In this paper dynamics, inverse dynamics, and control problems for multi-link flexible space manipulators are presented. In deriving the flexible manipulator dynamics the following are assumed: flexible deformations are relatively small; angular rates of the links are much smaller than their fundamental frequencies; nonlinear terms (centrifugal and Coriolis forces) in the flexible manipulator model are the same as those in the rigid body model. These assumptions are reasonable for large space manipulators, such as the space crane. Flexible displacements are measured with respect to the rigid body configuration, for which a linear time-varying system is obtained. The inverse dynamics problem consists of determination of joint torques, given tip trajectory, such that joint angles in flexible configuration are equal to the angles in the rigid body configuration. The manipulator control system consists of the feedforward compensation and feedback control loops. Simulation results of a two-link space crane with large payload show that the performance of this linearized dynamics and control approach is reasonable and robust subject to parameter variations during slew operations. Author

#### A90-47652#

#### DYNAMICS AND POSITIONING CONTROL OF SPACE ROBOT WITH FLEXIBLE MANIPULATORS

YOSHISADA MUROTSU, SHOZO TSUJIO, KEI SENDA (Osaka Prefecture, University, Sakai, Japan), and MASATO HAYASHI IN: AIAA Guidance, Navigation and Control Conference, Portland, OR, Aug. 20-22, 1990, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 735-742. refs

(AIAA PAPER 90-3397) Copyright

Advanced space robots consist of a satellite base to fly freely and manipulators with structural flexibility caused by requirement of a light weight system. Motions of manipulators influence positions and orientations of the satellite base because the system has no fixed supports. Motions of space robots also induce vibrational motions of structurally flexible manipulators. To control such complicated systems, a mathematical model of a space robot with structurally flexible manipulators is developed in this paper by using a Finite Element Method. An extended local PD-control scheme to control the flexible manipulators on a satellite base is proposed. The presented scheme is very simple and the stability of the closed loop system is proved by Liapunov's direct method. The effectiveness of the control scheme is also verified by numerical simulation. Author

#### A90-47653#

# MODEL-BASED ITERATIVE LEARNING CONTROL OF SPACE-SHUTTLE MANIPULATOR

B. PORTER and S. S. MOHAMED (Salford, University, England) IN: AIAA Guidance, Navigation and Control Conference, Portland, OR, Aug. 20-22, 1990, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 743-746. refs

(AIAA PAPER 90-3398) Copyright

It is shown that robotic manipulators give rise to completely irregular linear time-invariant plants under the action of computed-torque control, and therefore that previous results for the iterative learning control of regular plants are inapplicable in such cases. However, it is also shown that new results for the

### MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

iterative learning control of irregular plants are directly applicable to the design of iterative learning controllers for robotic manipulators. The practical relevance of these theoretical results to the design of model-based iterative learning controllers for robotic manipulators is illustrated by the presentation of numerical results for the iterative learning control of the manipulator in the Space Shuttle. Author

#### A90-47654#

### A PRELIMINARY STUDY ON EXPERIMENTAL SIMULATION OF DYNAMICS OF SPACE MANIPULATOR SYSTEM

HIRONORI FUJII, KOHJI SUGAHARA (Tokyo Metropolitan Institute of Technology, Japan), TAKASHI UCHIYAMA (Fujitsu Laboratories, Ltd., Kawasaki, Japan), and KENJI UCHIYAMA IN: AIAA Guidance, Navigation and Control Conference, Portland, OR, Aug. 20-22, 1990, Technical Papers. Part 1. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 747-752. refs (AIAA PAPER 90-3399) Copyright

A basic study is reported in this paper concerning a method to simulate on the ground the dynamics of a space manipulator. The space manipulator model is suspended from tethers at the joints of the links to cancel effects of the earth gravity in order to simulate its dynamics in space. Two cases of the system model of the manipulator arm are treated for the simulation: the first case assumes a simple model consisting of a rigid link, and the second case model consists of a link with structural flexibility in its structure. The results of the numerical simulation and on-ground experiment demonstrate the capability of the on-ground simulation. Author

#### A90-47684# THE INTRINSIC APPROACH TO SPACE ROBOTIC MANIPULATORS

M. SHEFER (Rafael Armament Development Authority, Haifa, Israel) IN: AIAA Guidance, Navigation and Control Conference, Portland, OR, Aug. 20-22, 1990, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics Astronautics, 1990, p. 1050-1055. refs and (AIAA PAPER 90-3431) Copyright

A novel approach to the robot rendezvous problem is presented, where the process' equations of motion are formulated in a coordinate frame that is attached to an intrinsic line of sight between the manipulator and the target. This enables one to cast the rendezvous problem into a form of a standard, yet nonlinear, regulation task about a universal zero set point, independent of the mission geometry. Optimal state feedback solution is subsequently obtained by solving the associated Dynamic Programming Equation off-line, ahead of time. The present algorithms are shown to admit a very simple and low cost implementation. Author

#### A90-47685#

### CAPTURE CONTROL FOR MANIPULATOR ARM OF FREE-FLYING SPACE ROBOT

TSUTOMU MURAYAMA, HIRONORI FUJII. KAZUNARI NAKAJIMA, and SEI-ICHI ANAZAWA (Tokyo Metropolitan Institute of Technology, Hino, Japan) IN: AIAA Guidance, Navigation and Control Conference, Portland, OR, Aug. 20-22, 1990, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 1056-1060. refs (AIAA PAPER 90-3432) Copyright

A control problem is studied in this paper: to capture an object by a manipulator arm of a free-flying space robot. The space robot consists of a rigid main body and a two-link manipulator. The robot is a type of the free-flying space robots and the position and attitude of the main body changes as the manipulator arm moves and changes its configuration. The changes in position and attitude of the main body cause significant complexity in the control of the manipulator arm in comparison with those robots operating on the ground with the fixed points or plane in inertial space. The control problem treated in this paper is for the manipulator arm of the space robot to capture any object which may be drifting in space and must be handled with

the manipulator arm of the robot. Only planar motion is treated in the course of this analysis for simplicity. The control algorithm employed is the 'Mission-Function Control' algorithm presented by the first author and is a type of the Liapunov method for nonlinear dynamical systems. Results of numerical simulation affirm excellent performance of the control algorithm applied to the control problem of the capture of an object by a manipulator arm of a free-flying space robot. Author

#### A90-47687#

#### SMART END EFFECTOR FOR DEXTEROUS MANIPULATION IN SPACE

KAZUO MACHIDA, YOSHITSUGU TODA, TOSHIAKI IWATA (Electrotechnical Laboratory, Tsukuba, Japan), SHOUICHI IIKURA, TADASHI KOMATSU (Toshiba Corp., Tokyo, Japan) et al. IN: AIAA Guidance, Navigation and Control Conference, Portland, OR, Aug. 20-22, 1990, Technical Papers. Part 2. Washington, DC, American Institute of Aeronautics and Astronautics, 1990, p. 1072-1078. refs

(AIAA PAPER 90-3434) Copyright

A smart end effector has been developed to add dexterous and flexible capability to coarse space work systems. It provides fine adjustment for precise error compensation by using a relative proximity sensor, and delicate force control by using a force-torque sensor. It also automatically tracks the marked target and capture it with specified impedance. The new mechanism of parallel link has been devised for the end effector, and the visual proximity sensor has been developed for six-dimensional position-attitude measurement of a flying target. The experiments are carried out using a two-dimensional air-bearing test bed, and sufficient performance has been achieved. Author

National Aeronautics and Space Administration. A90-49270\*# Ames Research Center, Moffett Field, CA.

#### HUMAN FACTORS IN THE PRESENTATION OF **COMPUTER-GENERATED INFORMATION - ASPECTS OF** DESIGN AND APPLICATION IN AUTOMATED FLIGHT TRAFFIC [MENSCHLICHE FAKTOREN BEI DER DARSTELLUNG VON RECHNERGENERIERTEN **INFORMATIONEN - DESIGN- UND ANWENDUNGSASPEKTE IM** AUTOMATISIERTEN FLUGVERKEHR]

RENATE J. ROSKE-HOFSTRAND (NASA, Ames Research Center, Moffett Field, CA; NASA, Langley Research Center, Hampton, Ortung und Navigation (ISSN 0474-7550), no. 1, 1990, p. VA) 29-45. In German. refs

The man-machine interface and its influence on the characteristics of computer displays in automated air traffic is discussed. The graphical presentation of spatial relationships and the problems it poses for air traffic control, and the solution of such problems are addressed. Psychological factors involved in the man-machine interface are stressed. C.D.

A90-49277\* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

#### MANUAL CONTROL ASPECTS OF SPACE STATION DOCKING MANEUVERS

ADAM R. BRODY (NASA, Ames Research Center; Sterling Software, Inc., Moffett Field, CA) and STEPHEN R. ELLIS (NASA, Ames Research Center, Moffett Field, CA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 8 p. refs

(SAE PAPER 901202) Copyright

Due to an increase in spacecraft traffic forecasted for the Space Station era, researchers are investigating manual control and other aspects of docking operations with hopes of increasing safety, productivity, and likelihood of success while deereasing cost. Experiments have been performed which revealed the effect of approach velocity, in-flight anomalies, and control mode. Displays have been designed to enable flight planners to more easily overcome the difficulties presented by orbital mechanics. Improved understanding of human factors in the docking mission and other orbital maneuvers will play a significant role in design tradeoffs concerning thruster size, docking fixture style and mass, and on-board trajectory planning displays. Incorporating both empirical and analytic results into current and future planning of missions occurring not only in earth orbit, but also for missions in lunar and Mars orbit, will expand the performance envelopes of the astronauts who participate in these missions. Author

#### A90-49278\* NASA Space Station Program Office, Reston, VA. WORK/CONTROL STATIONS IN SPACE STATION WEIGHTLESSNESS

CHARLES WILLITS (NASA, Space Station Freedom Program Office, Reston, VA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 39 p

(SAE PAPER 901203) Copyright

An ergonomic integration of controls, displays, and associated interfaces with an operator, whose body geometry and dynamics may be altered by the state of weightlessness, is noted to rank in importance with the optimal positioning of controls relative to the layout and architecture of 'body-ported' work/control stations applicable to the NASA Space Station Freedom. A long-term solution to this complex design problem is envisioned to encompass the following features: multiple imaging, virtual optics, screen displays controlled by a keyboard ergonomically designed for weightlessness, cursor control, a CCTV camera, and a hand-controller featuring 'no-grip' vernier/tactile positioning. This controller frees all fingers for multiple-switch actuations, while retaining index/register determination with the hand controller. A single architectural point attachment/restraint may be used which requires no residual muscle tension in either brief or prolonged operation. 00

#### A90-49279

### DESIGNING SPACE HABITATS FOR HUMAN PRODUCTIVITY

MARC M. COHEN (Michigan, University, Ann Arbor) SAE. Systems, 20th, Intersociety Conference on Environmental Williamsburg, VA, July 9-12, 1990. 15 p. refs (SAE PAPER 901204) Copyright

This summary paper addresses each of the key words in its title: Designing, Space Habitats and Productivity; from the perspective of a research architect. This approach looks at definitions of productivity in their specific economic, industrial, social and technical context. The discussion covers crew autonomy, democracy and teamwork as productivity values for space habitats. Author

#### A90-49280

#### JAPANESE RESEARCH ACTIVITIES OF LIFE SUPPORT SYSTEM

KEIJI NITTA, KOJI OTSUBO, SEISHIRO KIBE (National Aerospace Laboratory, Chofu, Japan), and HARUHIKO OHJA (Yokohama National University, Japan) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 16 p. refs

(SAE PAPER 901205) Copyright

Life-support technologies related to JEM development are outlined, with focus placed on air-conditioning and air-revitalization methods. The technology development of an advanced life-support system such as Closed Ecological Life Support System is covered. Attention is drawn to gas-separation and recycling systems, water-reclamation system, and waste-decomposition system. Plant and algae physiology and cultivation experiments are assessed, along with a recent strategic study regarding the Lunar Base. A system separating oxygen from photosynthetic reaction of plants cultivated in a food-production facility of the Lunar Base is considered, in addition to a nitrogen-fixation system, health-care system, and plant-cultivation facility. Attention is given to food nutrient analysis for determining plant cultivation planning. V.T.

#### A90-49281

#### MINIATURIZATION STUDY OF HEAT EXHAUSTING **RADIATOR OF LUNAR BASE**

IZUTANI, TADASHI OGURA, and HIROYASU NAOAKI YAMAMOTO (Daikin Industries, Ltd., Osaka, Japan) SAE.

Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 9 p. (SAE PAPER 901206) Copyright

Several programs for constructing the lunar base are in progress to develop lunar resources, such as helium 3. In order to remove heat from the lunar base, radiative heat exchangers can be used; these, however, have been estimated to be both large and heavy. To attain higher temperature level, a Rankine cycle booster heat-pump using high temperature refrigerant is added to a conventional cycle. A radiative heat exchanger composed of vertical radiating panels, horizontal reflections, and heat reservoirs, is selected to maximize capacity. The surface area of this radiative heat exchanger is estimated to be about 50 percent smaller than that of the conventional cycle. Author

### A90-49282

#### HUMAN REQUIREMENTS FOR QUALITY LIFE IN LUNAR BASE

T. FUJII, Y. MIDORIKAWA, M. SHIBA (JGC Corp., Tokyo, Japan), and K. NITTA (National Aerospace Laboratory, Chofu, Japan) SAE, Intersociety Conference on Environmental Systems, 20th. Williamsburg, VA, July 9-12, 1990. 13 p. refs (SAE PAPER 901207) Copyright

Future lunar crews with clearly defined functions and tasks to be performed as part of a daily routine will have many hours of leisure time to spend reading, listening to music, watching TV or engaging in artistic activities including painting and playing musical instruments. This paper reports on the crew's needs for lunar base life in terms of food, clothing, housing, communication, and mental and physical requirements. These items, or sectors, are divisible into three parts: basal life, passive pursuits, and active pursuits. Human needs develop to a higher degree of freedom

and options as the requirements expand from basal life to passive pursuits, and to active pursuits. Author

#### A90-49283

#### WATER RECYCLING SYSTEM FOR CELSS ENVIRONMENT IN SPACE

AKIRA ASHIDA, KENJI MITANI, HIDEAKI KUROKAWA, TOSHIO SAWA (Hitachi, Ltd., Tokyo, Japan), and KEIJI NITTA (National Aerospace Laboratory, Chofu, Japan) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990, 11 p. refs

(SAE PAPER 901208) Copyright

System configurations of water recycling for space use have been continued through theoretical and experimental studies. The water recycling system plays a central role in a Closed Ecological Life Support System which offers necessary environment and life styles in closed environment such as Space Stations, lunar bases, etc. Membrane technology is a possible candidate for purifying waste water produced by crew use facility, plant cultivation facility, etc. In consideration of the system compactness realizing energy saving, membrane distillation has been revealed to be a suitable purification process. Ground experiments have been performed using membrane filtration processes and membrane distillation process. Thermopervaporation technology with hydrophobic membrane is utilized in the distillation process. The energy saving is achieved by thermal return of condensation energy. Author

#### A90-49284

#### STATUS OF JEM ECLSS DESIGN

F. OTSUKI, T. SUZUKI, N. YAMAGUCHI (NASDA, Tokyo, Japan), A. HATTORI, Y. YOSHIDA (Kawasaki Heavy Industries, Ltd., Kobe, Japan) et al. SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 9 p. refs (SAE PAPER 901209) Copyright

The preliminary design of the Japanese Experiment Module (JEM) was started in January 1990. As a result of the JEM configuration review activity, which was focused on the development cost and schedule prior to getting into the preliminary design, a part of the JEM environmental control and life support system (ECLSS) functions was changed. This paper presents the JEM ECLSS baseline and the subsystem configuration at the start

# 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

of the Phase C/D. Also, the outline of the preliminary cabin air ventilation testing which started in March 1989 is described.

Author

A90-49285\* McDonnell-Douglas Space Systems Co., Huntsville, AL.

# PAST AND PRESENT ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEMS ON MANNED SPACECRAFT

BRYCE L. DIAMANT (McDonnell Douglas Space Systems Co., Huntsville, AL) and W. R. HUMPHRIES (NASA, Marshall Space Flight Center, Huntsville, AL) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 35 p. refs

(SAE PAPER 901210) Copyright

The spacecraft environmental control and life support systems (ECLSS) for Mercury, Gemini, Apollo, Skylab, Spacelab, the Space Shuttle Orbiter, and Space Station Freedom are reviewed, in addition to the ECLSS on Soviet spacecraft Vostok, Voskhod, Soyuz, Salyut Space Stations, the Buran Space Shuttle, and the Mir Space Station. Focus is placed on atmosphere control and supply, atmosphere revitalization, potable and supply water systems, waste-management systems, temperature and humidity control, water recovery and management, and fire detection and suppression. It is noted that the ECLSS evolution will continue during the lifetime of Space Station Freedom, leading to further simplifications and closure of the system which will become a controlled ecological life support system (CELSS). V.T.

**A90-49286\*** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

#### SPACE STATION FREEDOM ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM DESIGN - A STATUS REPORT

W. R. HUMPHRIES, J. L. REUTER, and R. G. SCHUNK (NASA, Marshall Space Flight Center, Huntsville, AL) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 18 p. refs

(SAE PAPER 901211) Copyright

Space Station Freedom (S.S. Freedom) has entered into the Preliminary Design Review (PDR) phase of the program. This paper outlines the Environmental Control and Life Support System (ECLSS) design with emphasis on the systems aspects of the ECLSS. Interactions with other distributed systems, such as data management and electrical power are described. The integration of the ECLSS into the S.S. Freedom pressurized elements and truss are addressed. Author

#### A90-49287

# OPTIMAL CONFIGURATION AND OPERATION FOR THE SPACE SHUTTLE FREEDOM ECLSS

WEN-HO CHU (Houston, University, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 20 p. refs

(SAE PAPER 901212) Copyright

The operations of the Space Station Freedom (SSF) Environmental Control and Life Support System (ECLSS) are determined by the configurations of the ECLSS subsystems. The configurations of the ECLSS subsystems are in turn determined by the NASA budget approved by Congress and the amount of money allocated to the SSF program. This paper uses the concepts of top-down techniques and the theory of optimization to present the mathematical formulations for determining the optimal configuration and optimal operation of the SSF ECLSS, based on different scenarios. The formulations can be used to determine the optimal number of units for the ECLSS processors to be configured, their recovery efficiencies, and the crew potable and hygiene water uses.

#### A90-49288

# SYSTEM LEVEL WATER BALANCE FOR SPACE STATION FREEDOM

DONALD H. SARGENT (Grumman Corp., Space Station Program Support Div., Reston, VA) SAE, Intersociety Conference on

Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 6 p. refs

(SAE PAPER 901213) Copyright

As a result of a 1989 program rephasing, Space Station Freedom's system-level water balances have been materially shifted. The average and the most likely values of the water balance, and the components of variability, were evaluated in this study. The Assembly Complete configuration has a large excess of ECLSS potable water but a deficit of ECLSS hygiene water. In contrast, there is a small ECLSS potable water deficit but an excess of ECLSS hygiene water for the 'Permanent Manned Capability' (PMC) configuration. Upon considering the Orbiter fuel cell water supply to the station and the combined demands for station water, the average and most likely values for the overall excess quantity are 6,800 and 9,000 pounds per year for the Assembly Complete configuration. Comparable values for the PMC configuration are 6,600 and 6,400 pounds per year.

A90-49289\* McDonnell-Douglas Space Systems Co., Huntsville, AL.

#### WATER RECOVERY AND MANAGEMENT TEST SUPPORT MODELING FOR SPACE STATION FREEDOM

HABIB MOHAMADINEJAD (McDonnell Douglas Space Systems Co., Huntsville, AL) and ALLEN S. BACSKAY (NASA, Marshall Space Flight Center, Huntsville, AL) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 21 p.

(SAE PAPER 901214) Copyright

The water-recovery and management (WRM) subsystem proposed for the Space Station Freedom program is outlined, and its computerized modeling and simulation based on a Computer Aided System Engineering and Analysis (CASE/A) program are discussed. A WRM test model consisting of a pretreated urine processing (TIMES), hygiene water processing (RO), RO brine processing using TIMES, and hygiene water storage is presented. Attention is drawn to such end-user equipment characteristics as the shower, dishwasher, clotheswasher, urine-collection facility, and handwash. The transient behavior of pretreated-urine, RO waste-hygiene, and RO brine tanks is assessed, as well as the total input/output to or from the system. The model is considered to be beneficial for pretest analytical predictions as a program cost-saving feature.

#### A90-49291

# LIFE SUPPORT FUNCTION AND TECHNOLOGY ANALYSIS FOR FUTURE MISSIONS

SUSAN C. DOLL and CARL M. CASE (Boeing Aerospace and Electronics, Seattle, WA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 10 p.

(SAE PAPER 901216) Copyright

A functional analysis was performed to identify life support functions and interrelationships required for manned space exploration. Methods were identified to provide each of these functions, ranging from resupply of consumables to totally regenerative processes. Specific mission characteristics and their effect on advanced life support requirements are outlined. A preliminary assessment is made as to which life support functions are critical for missions of various duration. Technologies which have been selected for Space Station Freedom and associated degrees of closure are discussed and areas for future work are suggested. Author

**A90-49301\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

QUALITY ASSESSMENT OF PLANT TRANSPIRATION WATER BRUCE A. MACLER (NASA, Ames Research Center, Moffett Field, CA), DANIEL S. JANIK, and BRIAN L. BENSON (Alabama, University, Huntsville) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 6 p. refs

# (SAE PAPER 901230) Copyright

It has been proposed to use plants as elements of

# 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

biologically-based life support systems for long-term space missions. Three roles have been brought forth for plants in this application: recycling of water, regeneration of air and production of food. This report discusses recycling of water and presents data from investigations of plant transpiration water quality. Aqueous nutrient solution was applied to several plant species and transpired water collected. The findings indicated that this water typically contained 0.3-6 ppm of total organic carbon, which meets hygiene water standards for NASA's space applications. It suggests that this method could be developed to achieve potable water standards. Author

### A90-49302

# ENGINEERING TESTBED FOR BIOLOGICAL WATER/AIR RECLAMATION AND RECYCLING

DANIEL S. JANIK (Cetus Research, El Cerrito, CA) and JEFFERY J. DEMARCO (Pyraponic Industries, Inc., San Diego, CA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 9 p. refs (SAE PAPER 901231) Copyright

Experience with reclaimed and recycled life support testbeds is necessary to identify problems unique to this new class of spacecraft systems. Current research and engineering testbeds necessary for advanced Space Station Freedom, moonbase, interplanetary travel and Mars/Phobos mission and base are large, complex, costly and rare. This paper reports on a small, simple, flexible and affordable experimental research and engineering testbed for biologically contaminated or enhanced physical chemical and biological water/air reclamation and recycling systems. Author

#### A90-49303

### BIOSPHERE 2 PROJECT STATUS - DESIGN OF A CLOSED MANNED TERRESTRIAL ECOLOGICAL SYSTEM

WILLIAM F. DEMPSTER (Space Biospheres Ventures, Oracle, AZ) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 6 p.

(SAE PAPER 901233) Copyright

The major features and current status of Biosphere 2, a 3.15 acre materially closed, manned ecological system (bioregenerative life support system) are described. Biosphere 2 represents seven bionic regions, five natural and two anthropogenic: savannah, marsh, tropical rainforest, ocean, desert, intensive agriculture, and human habitat. It is concluded that development of the knowledge to assemble an artificial biosphere offers unprecedented insights into the biospheric system of the earth and studies of space habitation. R.E.P.

A90-49312\* National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD. LOW-TEMPERATURE THERMAL CONTROL FOR A LUNAR

# LOW-TEMPERATURE THERMAL CONTROL FOR A LUNAR BASE

THEODORE D. SWANSON (NASA, Goddard Space Flight Center, Greenbelt, MD), REINHARD RADERMACHER (Maryland, University, College Park), FREDERICK A. COSTELLO (Frederick A. Costello, Inc., Herndon, VA), JAMES S. MOORE, JR., and DAVID R. MENGERS SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 17 p. (SAE PAPER 901242) Copyright

The generic problem of rejecting low- to moderate-temperature heat from space facilities located in a hot thermal sink environment is studied, and the example of a lunar base located near the equator is described. The effective thermal sink temperature is often above or near nominal room temperature. A three heat pump assisted thermal bus concept appears to be the most viable as they are the least sensitive to environmental conditions. Weight estimates are also developed for each of the five thermal control concepts studied: (1) 149kg/kW for a central thermal loop with unitary heat pumps; (2) 133 kg/kW for a conventional bus connected to large, central heat pumps at the radiator; (3) 134 kg/kW for a central, dual loop heat pump concept; (4) 95 kg/kW for the selective field-of-view radiator; and (5) 126 kg/kW for the regolith concept.

**A90-49313\*** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

# ACTIVE THERMAL CONTROL SYSTEMS FOR LUNAR AND MARTIAN EXPLORATION

MICHAEL K. EWERT, PATRICIA A. PETETE, and JOHN DZENITIS (NASA, Johnson Space Center, Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 13 p. refs

(SAE PAPER 901243) Copyright

Several ATCS options including heat pumps, radiator shading devices, and single-phase flow loops were considered. The ATCS chosen for both lunar and Martian habitats consists of a heat pump integral with a nontoxic fluid acquisition and transport loop, and vertically oriented modular reflux-boiler radiators. The heat pump operates only during the lunar day. The lunar and Martian transfer vehicles have an internal single-phase water-acquisition loop and an external two-phase ammonia rejection system with rotating inflatable radiators. The lunar and Martian excursion vehicles incorporate internal single-phase water acquisition, which is connected via heat exchangers to external body-mounted single-phase radiators. A water evaporation system is used for the transfer vehicles during periods of high heating. Author

#### A90-49314

# DEVELOPMENT OF THE SUIT ENCLOSURE OF THE EUROPEAN EVA SPACE SUIT

Y. OLLIVIER (AMDBA, Saint-Cloud, France) and M. DIENER (Dornier GmbH, Friedrichshafen, Federal Republic of Germany) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 11 p. Research supported by ESA.

(SAE PAPER 901244) Copyright

The effort carried out in Europe for the design and development of an EVA suit enclosure module (ESEM) operating at 500 hPa within the framework of the development studies of the Hermes EVA system is presented. The ESEM design is supported by technology studies focused on a breadboard manufacturing and testing program. A glove breadboard is tested in a dedicated glove box and a material screening is performed leading to an arm thermal protection and an elbow soft joint respectively thermally and mechanically tested. These technology programs and a general definition study of the ESEM flight model are described. R.E.P.

### A90-49315

# EVA LIFE SUPPORT DESIGN ADVANCEMENTS

ROLAND VAETH and A. INGEMAR SKOOG (Dornier GmbH, Friedrichshafen, Federal Republic of Germany) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 19 p.

(SAE PAPER 901245) Copyright

The European Space Agency has initiated the development of a system for Extra Vehicular Activities (EVA), which will allow European astronauts to work in space. The key element in this development is a space suit. This paper provides the development status of critical technologies started in this predevelopment phase with respect to the EVA life support functions. The results of these technology investigations on breadboard model level will be used as starting point for the Phase C/D to reduce the development risk. This European EVA Space Suit System shall be operational for the first manned Hermes flight in 1999. Author

# A90-49316

# EMULATION OF THE EVA SOVIET SUIT FOR NEUTRAL BUOYANCY SIMULATIONS

D. HORNET (AMDBA, Vaucresson, France), L. DECRAMER, M. TOGNINI (CNES, Paris, France), and C. GORTAN (Compagnie Maritime d'Expertises, Marseille, France) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 11 p.

(SAE PAPER 901246) Copyright

DASSAULT and COMEX have developed a 'wet' suit prototype, under a one year CNES contract, for the simulation of the Soviet EVA flight suit during underwater trainings. This concept, full of water and requiring a breathing system, allows to perfectly balance the astronaut in a neutrally buoyant suit like in O-g environment. The modeling of real pressurized joints has been overcome by means of adjustable mechanical articulations the principle of which is fully described. The prototype performances and representativity have been evaluated and validated through underwater donning/doffing and the replay of an actual EVA already performed in space by Soviet-French astronauts. This suit prototype is available today, for the European space system designers to evaluate the future EVA operations to refine the procedures and hardware requirements. The suit concept capabilities, linked to its high modularity and low development duration, are finally discussed.

#### A90-49317

### WATER RECYCLING IN SPACE

R. F. MADSEN, J. R. THOMASSEN, L. B. JORGENSEN (Danisco A/S, Denmark), J.-L. BERSILLON, D. VIAL (Lyonnaise des Eaux, France) et al. SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 19 p. (SAE PAPER 901247) Copyright

The results of the preliminary studies of water recycling for ESA are presented. The main conclusion is that the treatments for all waste waters, except urine, should consist of (1) pretreatment (acidification, H2O2 addition, and filtration); (2) reverse osmosis; (3) oxidation (H2O2 + UV light); and (4) reverse osmosis (neutral pH). Together with reject from reverse osmosis, urine is treated by vapor compression distillation. Microbiological studies have been made, and practical experiments with RO on shower water are mentioned. It is shown that up to 98 percent recovery can be obtained with a power consumption of 45-60 Wh/liter.

#### A90-49318

# LIFE SUPPORT - THOUGHTS ON THE DESIGN OF SAFETY SYSTEMS

ROBIN C. HUTTENBACH and STEPHEN D. ORAM (Nelson Space Services, Ltd., London, England) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 14 p. Research supported by ESA.

(SAE PAPER 901248) Copyright

This paper considers the design of safety systems as they might be applied to a manned habitat operating in space. Areas reviewed include the delineation, monitoring and suppression of hazards as well as the design of control systems. Examples of methods that could be used to suppress hazards are presented, including schematics for a shut-down hierarchy and a fire and hazardous gas control system. Author

#### A90-49319

# PUMPING EQUIPMENT OF AUTONOMOUS INHABITED SYSTEMS

V. N. VASIL'EV, I. D. OSHMARIN, B. G. RITTENBERG, M. A. ROGUNOV, V. B. FILONENKO (Nauchno-Proizvodstvennoe Ob'edinenie VNIIGIDROMASH, Moscow, USSR) et al. SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 21 p. refs (SAE PAPER 901250) Copyright

Practically any processes vital for autonomous inhabited

systems require forced transfer of liquids. Therefore, such systems normally incorporate pumps of various types. The specific features of the autonomous inhabited systems result in the fact that the pumping equipment of these systems also has some specific features. The methods of selecting a particular type of pump and general estimate of its specific features are considered for one typical kind of autonomous inhabited system, i.e., for the life-support and survival systems of space vehicles. Author

A90-49320\* Alabama Univ., Huntsville.

#### HUMAN SUBJECTS CONCERNS IN GROUND BASED ECLSS TESTING - MANAGING UNCERTAINTY IN CLOSELY RECYCLED SYSTEMS

WILLIAM J. CRUMP, DANIEL S. JANIK (Alabama, University, Huntsville), and L. DALE THOMAS (NASA, Marshall Space Flight Center, Huntsville, AL) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 12 p. refs

(SAE PAPER 901251) Copyright

U.S. space missions have to this point used water either made on board or carried from earth and discarded after use. For Space Station Freedom, long duration life support will include air and water recycling using a series of physical-chemical subsystems. The Environmental Control and Life Support System (ECLSS) designed for this application must be tested extensively at all stages of hardware maturity. Human test subjects are required to conduct some of these tests, and the risks associated with the use of development hardware must be addressed. Federal guidelines for protection of human subjects require careful consideration of risks and potential benefits by an Institutional Review Board (IRB) before and during testing. This paper reviews the ethical principles guiding this consideration, details the problems and uncertainties inherent in current hardware testing, and presents an incremental approach to risk assessment for ECLSS testing.

Author

#### A90-49321\* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

### PHASE III SIMPLIFIED INTEGRATED TEST (SIT) RESULTS -SPACE STATION ECLSS TESTING

BARRY C. ROBERTS, ROBYN L. CARRASQUILLO, MELISSA Y. DUBIEL, KATHRYN Y. OGLE, JAY L. PERRY, and KEN M. WHITLEY (NASA, Marshall Space Flight Center, Huntsville, AL) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 8 p.

(SAE PAPER 901252) Copyright

During 1989, phase III testing of Space Station Freedom Environmental Control and Life Support Systems (ECLSS) began at Marshall Space Flight Center (MSFC) with the Simplified Integrated Test. This test, conducted at the MSFC Core Module Integration Facility (CMIF), was the first time the four baseline air revitalization subsystems were integrated together. This paper details the results and lessons learned from the phase III SIT. Future plans for testing at the MSFC CMIF are also discussed.

Author

**A90-49322\*** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

# TEST BED DESIGN FOR EVALUATING THE SPACE STATION ECLSS WATER RECOVERY SYSTEM

TIMOTHY G. EZELL and DAVID A. LONG (NASA, Marshall Space Flight Center, Huntsville, AL) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 23 p. refs

(SAE PAPER 901253) Copyright

The design of the Phase III Environmental Control and Life Support System (ECLSS) Water Recovery System (WRS) test bed is in progress at the Marshall Space Flight Center (MSFC), building 4755, in Huntsville, Alabama. The overall design for the ECLSS WRS test bed will be discussed. Described within this paper are the design, fabrication, placement, and testing of the supporting facility which will provide the test bed for the ECLSS subsystems. Topics to be included are sterilization system design, component selection, microbial design considerations, and verification of test bed design prior to initiating WRS testing.

# A90-49323\* Boeing Co., Seattle, WA.

#### FACILITY FOR GENERATING CREW WASTE WATER PRODUCT FOR ECLSS TESTING

ALAN BUITEKANT (Boeing Aerospace and Electronics, Seattle, WA) and BARRY C. ROBERTS (NASA, Marshall Space Flight Center, Huntsville, AL) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 12 p. refs

(SAE PAPER 901254) Copyright

An End-use Equipment Facility (EEF) has been constructed which is used to simulate water interfaces between the Space Station Freedom Environmental Control and Life Support Systems (ECLSS) and man systems. The EEF is used to generate waste water to be treated by ECLSS water recovery systems. The EEF will also be used to close the water recovery loop by allowing test subjects to use recovered hygiene and potable water during several phases of testing. This paper describes the design and basic operation of the EEF. Author

#### A90-49324

#### LIQUID CHROMATOGRAPHY/MASS SPECTROMETRY - A NEW TECHNIQUE FOR WATER RECOVERY SYSTEM TESTING

BRIAN L. BENSON, STUART A. OEHRLE, and MELVIN V. KILGORE, JR. (Alabama, University, Huntsville) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 8 p. refs

(SAE PAPER 901255) Copyright

Liquid Chromatography/Mass Spectrometry can improve Freedom water recovery systems testing by providing analytical information about nonvolatile organic contaminants not amenable to conventional analytic techniques. A preliminary liquid chromatography method has been developed for organic acids in human urine. Using this method, over twenty organic acids and related compounds can be resolved. Author

#### A90-49325

#### ATMOSPHERE COMPOSITION MONITOR FOR PREDEVELOPMENT OPERATIONAL SYSTEM TEST

RICHARD A. HEPPNER, DIEGO A. TORRES (Perkin-Elmer Corp., Applied Science Div., Pomona, CA), and JEFF HISS (Boeing Aerospace and Electronics, Huntsville, AL) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 9 p.

# (SAE PAPER 901256) Copyright

Perkin-Elmer is providing the Atmosphere Composition Monitor (ACM) for the Space Station Freedom Environmental Control and Life Support System (ECLSS) being developed by Boeing Aerospace and Electronics (BA&E). Prior to production of flight hardware the ECLSS system will be tested in the Predevelopment Operational System Test (POST). 'Predevelopment' or POST equipment must meet flight hardware functional requirements, but not size, weight, and power goals. The POST ACM consists of the following major modules: a Major Constituent Analyzer, a Trace Contaminant Monitor, a Carbon Monoxide Analyzer, a Particle Counter Monitor, a Sample Acquisition System and a Computer System. The Predevelopment ACM is designed for automated operation; operator intervention is required only for maintenance. Instrument performance is verified through periodic measurement of reference gas standards.

#### A90-49326

#### OPERATIONAL NINETY-DAY MANNED TEST OF REGENERATIVE LIFE SUPPORT SYSTEMS

TERRY C. SECORD and MARIO S. BONURA (McDonnell Douglas Space Systems Co., Huntington Beach, CA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 11 p. refs

(SAE PAPER 901257) Copyright

A summary is presented of the results of the last known closed-door manned chamber test of an operational regenerative life-support system which took place in the Space Station Simulator in 1970. The 90-day test included the evaluation of a number of advanced life-support subsystems with backup provided by alternate subsystems that had undergone extensive manned testing during the middle 1960s. Data were collected on the performance of the equipment, the four-man crew, and the man/system interface. It was found that no psychological or physiological effects were experienced by the confined crew who used the recovered water and oxygen, and that there was time to troubleshoot and repair malfunctioning equipment. Test results aided in developing a strategy to improve equipment designs for Skylab and the Space Station, and to increase understanding of design impacts of closing the water and oxygen cycles. IKS

#### A90-49332

# LSOPP II - A PROGRAM FOR ADVANCED EVA SYSTEM MODELING AND TRADE STUDIES

BRIAN E. AMES and JOHN V. IOVINE (Lockheed Engineering and Sciences Co., Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 10 p. refs

(SAE PAPER 901264) Copyright

A computer analysis program designed to predict and evaluate the steady state performance and size of integrated extravehicular mobility unit life support systems has been developed for advanced missions. Trade study evaluations for various extravehicular activity technologies can be accomplished using the Life Support Options Performance Program, version 2.0 (LSOPP II). LSOPP II is an interactive menu-driven program based upon a dual loop structure (vent loop - water loop). It solves for the outlet flow conditions of each component in a loop, given the associated heat loads and inlet flow conditions. System and component results of LSOPP II include heat load, flow rate, pressure, temperature, power, weight, and volume.

#### A90-49333

### APPLICATION OF A COMPREHENSIVE G189A ECLSS MODEL IN ASSESSING SPECIFIC SPACE STATION CONDITIONS

R. S. BARKER and R. G. VON JOUANNE (Boeing Aerospace and Electronics, Huntsville AL) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 17 p. refs

(SAE PAPER 901265) Copyright

A comprehensive environmental control and life support system model developed using the G189A environment control system simulation tool is described. The computational logic and input data for the atmosphere control and supply, atmosphere revitalization, water recovery and management, and temperature and humidity control have been verified while analyzing the performance under normal operating conditions and the effects during an orbiter docking maneuver accompanied by a changeout of crews. All ECLSS operating conditions during crew changeout were determined to be within limits, except possibly the levels of CO2. These CO2 levels were temporarily greater than the established limits for normal operating conditions, but were well within the accepted emergency operating conditions. A series of modeling schematics is included. R.E.P.

A90-49335\* Lockheed Engineering and Sciences Co., Houston, TX.

#### INTEGRATED MODEL OF G189A AND ASPEN-PLUS FOR THE TRANSIENT MODELING OF EXTRAVEHICULAR ACTIVITY ATMOSPHERIC CONTROL SYSTEMS

MATTHEW KOLODNEY and BRUCE C. CONGER (Lockheed Engineering and Sciences Co., Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 13 p. Research supported by NASA.

(SAE PAPER 901268) Copyright

A computerized modeling tool, under development for the transient modeling of an extravehicular activity atmospheric control subsystem is described. This subsystem includes the astronaut, temperature control, moisture control, CO2 removal, and oxygen make-up components. Trade studies evaluating competing components and subsystems to guide the selection and development of hardware for lunar and Martian missions will use this modeling tool. The integrated modeling tool uses the Advanced System for Process Engineering (ASPEN) to accomplish pseudosteady-state simulations, and the general environmental thermal control and life support program (G189A) to manage overall control of the run and transient input output, as well as transient modeling computations and database functions. Flow charts and flow diagrams are included.

A90-49336\* McDonnell-Douglas Space Systems Co., Huntsville, AL.

### COMPUTER AIDED SYSTEM ENGINEERING AND ANALYSIS (CASE/A) MODELING PACKAGE FOR ECLS SYSTEMS - AN OVERVIEW

ROBERT C. DALEE (McDonnell Douglas Space Systems Co., Huntsville, AL), ALLEN S. BACSKAY, and JAMES C. KNOX (NASA, Marshall Space Flight Center, Huntsville, AL) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990, 18 p. refs

(SAE PAPER 901267) Copyright

An overview of the CASE/A-ECLSS series modeling package is presented. CASE/A is an analytical tool that has supplied engineering productivity accomplishments during ECLSS design activities. A components verification program was performed to assure component modeling validity based on test data from the Phase II comparative test program completed at the Marshall Space Flight Center. An integrated plotting feature has been added to the program which allows the operator to analyze on-screen data trends or get hard copy plots from within the CASE/A operating environment. New command features in the areas of schematic, output, and model management, and component data editing have been incorporated to enhance the engineer's productivity during a modeling program. R.E.P.

#### A90-49337\* New South Wales Univ., Kensington (Australia). A PROTOTYPE COMPUTER-AIDED MODELLING TOOL FOR LIFE-SUPPORT SYSTEM MODELS

H. A. PREISIG (New South Wales, University, Kensington, Australia), TAE-YEONG LEE, and FRANK LITTLE (Texas A & M University, College Park) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 12 p. Research supported by NASA.

(SAE PAPER 901269) Copyright

Based on the canonical decomposition of physical-chemical-biological systems, a prototype kernel has been developed to efficiently model alternative life-support systems. It supports (1) the work in an interdisciplinary group through an easy-to-use mostly graphical interface, (2) modularized object-oriented model representation, (3) reuse of models, (4) inheritance of structures from model object to model object, and (5) model data base. The kernel is implemented in Modula-II and presently operates on an IBM PC. Author

#### A90-49347

#### THE DEVELOPMENT OF THE HUMAN WASTE COLLECTION **ASSEMBLY FOR HERMES**

GERHARD TRAXLER (Oesterreichische Raumfahrtund Systemtechnik GmbH, Vienna, Austria) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990, 12 p. refs

(SAE PAPER 901287) Copyright

The paper describes the development of a toilet system, the so-called Human Waste Collection Assembly (HWCA) for use in the HERMES spaceplane. The basic concept, which relies on the forced air method for separation of the waste material from the human body and on a subsequent mechanical compaction process, is presented, and the specific problems encountered and still to be foreseen in the development program are highlighted. The basic concept has been optimized with respect to its implementation in the HERMES spaceplane, meeting the stringent envelope requirements on-board. Critical development issues have been identified and are now under investigation by breadboarding.

#### A90-49348

#### ATMOSPHERE TRACE GAS CONTAMINATION MANAGEMENT FOR THE COLUMBUS PRESSURIZED MODULES

HERMANN ABELE (Dornier GmbH, Friedrichshafen, Federal Republic of Germany), KLAUS AMMANN (Draegerwerk AG, Luebeck, Federal Republic of Germany), and JOCHEN FRANZEN (Bruker-Franzen Analytik GmbH, Bremen, Federal Republic of

SAE, Intersociety Conference on Environmental Germany) Systems, 20th, Williamsburg, VA, July 9-12, 1990. 6 p. refs (SAE PAPER 901288) Copyright

The COLUMBUS pressurized modules APM and PM2 are designed for a useful lifetime of 30 years. The APM, which forms part of the International Space Station, will be permanently manned with a three-man crew. The PM2, which is the pressurized module of the Men-Tended-Free-Flyer (MTFF) will be manned for the servicing period of 10 days followed by a 180-day unmanned period. In order to protect the crew from contamination by hazardous substances, which may be present in the cabin air, effective contamination management is required. This consists of a contamination monitoring system to detect and measure trace gases in the cabin atmosphere, and a contamination control system to be able to maintain the concentration of each potential contaminant below the maximum allowable concentration.

Author

#### A90-49349

### ECLS TECHNOLOGY DEVELOPMENT PROGRAMME -**RESULTS AND FURTHER ACTIVITIES**

WOLFRAM KNORR, HELMUT FUNKE, HELMUT PREISS (Dornier GmbH, Friedrichshafen, Federal Republic of Germany), and GIJSBERT TAN (ESTEC, Noordwijk, Netherlands) SAE. Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 12 p. Research supported by DLR. refs

(SAE PAPER 901289) Copyright

A technological program was started in 1985 to support the Columbus environmental control and life support system (ECLSS) development. The program goal has been the development of an advanced breadboard for: (1) a regenerative CO2 removal system, (2) a trace gas contamination control system, (3) a trace gas contamination monitoring system, and (4) a low-noise variable speed fan. Results of the program indicate that the concept of the solid-amine-based regenerative CO2 removal could be largely advanced, and the trace gas contamination control assembly proved its feasibility. R.E.P.

### A90-49350

#### CONSTRAINTS AND RATIONALE FOR SPACE STATION FREEDOM HABITATION AND LABORATORY MODULE TOPOLOGY

JOHN R. PALMER, WILLIAM P. LLOYD, and CANDACE CAMPBELL (Boeing Aerospace and Electronics, Huntsville, AL) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 18 p. (SAE PAPER 901297) Copyright

This paper addresses the constraints concerning the allocation of equipment to volume within two of the pressurized, habitable modules of Space Station Freedom. This problem of topology optimization must address multiple competing constraints at various stages of the design evolution. Consistent and logical balance of conflicting location constraints is the objective in design optimization. This study defines the physical, functional, and operational constraints affecting the optimization of the Space Station Freedom Habitation and U.S. Laboratory module configurations, and discusses the evolution of their current baseline. Author

#### A90-49351

Author

#### DESIGN DEFINITION OF THE SPACE STATION FREEDOM GALLEY AND WARDROOM SUBSYSTEMS AND THEIR EFFECT ON SPACE STATION ENVIRONMENTAL SYSTEMS

MARTIN AGRELLA, AL KWAN, and JON ZELON (ILC Space Systems, Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 12 p.

(SAE PAPER 901299) Copyright

This paper describes the current Space Station Freedom (SSF) Galley and Wardroom system designs which enhance crew productivity and comfort, ensure crew safety, minimize technical impacts on the SSF Environmental Control and Life Support System

(ECLSS) and allow for future SSF growth/modification. The discussion presented encompasses the design definition of the Galley and Wardroom integrated systems, identification of heat loads and contaminants that affect the SSF ECLSS, and the design approach taken to incorporate localized water and air treatment to minimize the impact on the SSF ECLSS. Author

### A90-49352

#### DEVELOPMENT OF THE SPACE STATION FREEDOM **REFRIGERATOR/FREEZER AND FREEZER**

JON ZELON, JOHN SAIZ (ILC Space Systems, Houston, TX), and PETER GLASER (Arthur D. Little, Inc., Cambridge, MA) SAF Intersociety Conference on Environmental Systems, 20th. Williamsburg, VA, July 9-12, 1990. 14 p. (SAE PAPER 901300) Copyright

This paper presents the current design configuration of the Space Station Freedom (SSF) Refrigerator/Freezer and Freezer (R/F and F) systems. In addition, this paper establishes the current analyses/trade study activity related to refrigeration system design and defines Environmental Control and Life Support System (ECLSS) interfaces, anticipated heat loads, maintenance approaches and safety concerns. Author

#### A90-49353

#### SPACE STATION CREW QUARTERS AND PERSONAL HYGIENE FACILITY

LOUIS P. DIETZ and GARY L. DOERRE (Grumman Corp., Space Systems Div., Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 14 p. refs

(SAE PAPER 901301) Copyright

The history of U.S. spacecraft Crew Quarters and Personal Hygiene Systems is traced from the time of the early space capsules through the present day Shuttle. Brief descriptions of these accommodations are provided. Design goals are defined for the Space Station Freedom Crew Quarters and Personal Hygiene so that the successes, or failures of each step of the space program can be compared and our progress thus measured. The Space Station Freedom requirements and preliminary design efforts for these facilities are described to considerable depth. Particular emphasis is given to sleeping arrangements and equipment of the Crew Quarters and the commode-urinal, zero gravity handwasher, and the zero gravity shower of the Space Station. Concerns and issues are discussed and an overview or summary is provided. Author

#### A90-49354

#### SPACE STATION FREEDOM SCIENCE SUPPORT EQUIPMENT

J. M. SMITH, W. G. DEAN, JR., and J. W. ANGELI (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 9 p.

(SAE PAPER 901302) Copyright

Space Station Freedom equipment is being developed to support future research in the life sciences and material sciences. This pape focuses on the preservation and storage equipment, and the trace contaminant control system. The preservation and storage equipment includes cryogenic freezers (-196 C) for specimen quick-freezing and storage, a freeze drier, and a -70 C freezer for general storage. A predevelopment Trace Contaminant Control System has been built to support Environmental Control and Life Support System testing. The hardware will be used in the Predevelopment Operational System Test to verify design interfaces with other subsystems of the air revitalization system. Author

### A90-49368

#### COMPUTER SIMULATION OF A REGENERATIVE LIFE SUPPORT SYSTEM FOR A LUNAR BASE

STEPHEN R. GUSTAVINO, MELANIE M. MANKAMYER, and ANDREA M. GARDNER (McDonnell Douglas Space Systems Co., Huntington Beach, CA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 14 p. refs

(SAE PAPER 901329) Copyright

The options available for regenerative environmental control and life support systems (ECLSS) design for use on a lunar base and the potential role of computer modeling in analysis of the advantages and disadvantages of various system configurations are described. A bioregenerative ECLSS flow diagram is presented and regenerative ECLSS options are discussed, noting that such technology would significantly reduce operational cost and is necessary for extended missions, such as the exploration of Mars. Resources existing in the lunar environment and their potential roles in a regenerative ECLSS design for a lunar base are discussed and special attention is paid to water regeneration. L.K.S.

A90-49370\* Lockheed Engineering and Sciences Co., Houston, TX.

#### ADVANCED AIR REVITALIZATION SYSTEM MODELING AND TESTING

LIESE DALL-BAUMANN, FRANK JENG, STEVE CHRISTIAN (Lockheed Engineering and Sciences Co., Houston, TX), MARYBETH EDEER, and CHIN LIN (NASA, Johnson Space Center, Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 12 p. refs (SAE PAPER 901332) Copyright

To support manned lunar and Martian exploration, an extensive evaluation of air revitalization subsystems (ARS) is being conducted. The major operations under study include carbon dioxide removal and reduction; oxygen and nitrogen production, storage, and distribution; humidity and temperature control; and trace contaminant control. A comprehensive analysis program based on a generalized block flow model was developed to facilitate the evaluation of various processes and their interaction. ASPEN PLUS was used in modelling carbon dioxide removal and reduction. Several life support test stands were developed to test new and existing technologies for their potential applicability in space. The goal was to identify processes which use compact, lightweight equipment and maximize the recovery of oxygen and water. The carbon dioxide removal test stands include solid amine/vacuum desorption (SAVD), regenerative silver oxide chemisorption, and electrochemical carbon dioxide concentration (EDC). Membrane-based carbon dioxide removal and humidity control, catalytic reduction of carbon dioxide, and catalytic oxidation of trace contaminants were also investigated. B.P.

#### A90-49371\* Massachusetts Inst. of Tech., Cambridge. OXIDATION KINETICS OF MODEL COMPOUNDS OF METABOLIC WASTE IN SUPERCRITICAL WATER

PAUL A. WEBLEY, HENRY R. HOLGATE, DAVID M. STEVENSON, and JEFFERSON W. TESTER (MIT, Cambridge, MA) SAF Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 21 p. refs (Contract NAG9-252)

(SAE PAPER 901333) Copyright

In this NASA-funded study, the oxidation kinetics of methanol and ammonia in supercritical water have been experimentally determined in an isothermal plug flow reactor. Theoretical studies have also been carried out to characterize key reaction pathways. Methanol oxidation rates were found to be proportional to the first power of methanol concentration and independent of oxygen concentration and were highly activated with an activation energy of approximately 98 kcal/mole over the temperature range 480 to 540 C at 246 bar. The oxidation of ammonia was found to be catalytic with an activation energy of 38 kcal/mole over temperatures ranging from 640 to 700 C. An elementary reaction model for methanol oxidation was applied after correction for the effect of high pressure on the rate constants. The conversion of methanol predicted by the model was in good agreement with experimental data. Author

# 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

A90-49384\* McDonnell-Douglas Space Systems Co., Houston, TX.

# SPACE STATION ENVIRONMENTAL HEALTH SYSTEM WATER QUALITY MONITORING

JOHANNA E. VINCZE (McDonnell Douglas Space Systems Co., Houston, TX) and RICHARD L. SAUER (NASA, Johnson Space Center, Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 8 p.

# (SAE PAPER 901351) Copyright

One of the unique aspects of the Space Station is that it will be a totally encapsulated environment and the air and water supplies will be reclaimed for reuse. The Environmental Health System, a subsystem of CHeCS (Crew Health Care System), must monitor the air and water on board the Space Station Freedom to verify that the quality is adequate for crew safety. Specifically, the Water Quality Subsystem will analyze the potable and hygiene water supplies regularly for organic, inorganic, particulate, and microbial contamination. The equipment selected to perform these analyses will be commercially available instruments which will be converted for use on board the Space Station Freedom. Therefore, the commercial hardware will be analyzed to identify the gravity dependent functions and modified to eliminate them. The selection. analysis, and conversion of the off-the-shelf equipment for monitoring the Space Station reclaimed water creates a challenging project for the Water Quality engineers and scientists. Author

#### A90-49385\* Little (Arthur D.), Inc., Cambridge, MA. A VOLATILE ORGANICS CONCENTRATOR FOR USE IN MONITORING SPACE STATION WATER QUALITY

DANIEL J. EHNTHOLT, ITAMAR BODEK, JAMES R. VALENTINE (Arthur D. Little, Inc., Cambridge, MA), RUDY TRABANINO, JOHANNA E. VINCZE (McDonnell Douglas Space Systems Co., Houston, TX), and RICHARD L. SAUER (NASA, Johnson Space Center, Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 14 p.

# (SAE PAPER 901352) Copyright

The process used to identify, select, and design an approach to the isolation and concentration of volatile organic compounds from a water sample prior to chemical analysis in a microgravity environment is discerned. The trade analysis leading to the recommended volatile organics concentrator (VOC) concept to be tested in a breadboard device is presented. The system covers the areas of gases, volatile separation from water, and water removal/gas chromatograph/mass spectrometer interface. Five options for potential use in the VOC and GC/MS system are identified and ranked, and also nine options are presented for use in the water removal/GC column and MS interface are also identified and included in the overall considerations. A final overall recommendation for breadboard VOC testing is given. L.K.S.

#### A90-49386

# DETECTION OF GAS LOADING OF THE WATER ONBOARD SPACE STATION FREEDOM

D. C. SMITH, J. A. HOWARD, JR., and S. K. ROSE (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 10 p.

### (SAE PAPER 901353) Copyright

Because of gastrointestinal discomfort associated with the ingestion of gas-loaded water in microgravity, it is important to monitor the gas content of the potable water onboard Space Station Freedom. A major potential constituent of this gas is nitrogen, which cannot be detected in aqueous solution by electrodes or by spectrophotometric methods. This paper concerns Lockheed's work in behalf of McDonnell Douglas Space Systems Company for NASA's Space Station Work Package 2. As part of the environmental monitoring subsystem for the Crew Health Care System, Lockheed is developing an Optical Water Quality Analyzer. An important feature of this instrument is the ability to unload and measure the gas content of the water sample.

# A90-49387

# NEW TOTAL ORGANIC CARBON ANALYZER

RICHARD D. GODEC, PAUL P. KOSENKA, and RICHARD S. HUTTE (Sievers Research, Inc., Boulder, CO) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 11 p. Research supported by McDonnell Douglas Astronautics Co. refs

(SAE PAPER 901354) Copyright

The development of a high sensitivity, compact monitor for the measurement of total organic carbon (TOC) in water with no gravity-dependent components is discussed. The system is based on a combination of photo-catalzyed oxidation of organic compounds to form carbon dioxide, which is selectively measured using a gas permeable membrane and conductometric detection. This unique combination permits the development of a TOC analyzer with significant advantages over existing methods for TOC analysis including high sensitivity (i.e., detection limits at low parts per billion TOC concentrations), a linear response over a wide range of TOC concentrations (at least four orders of magnitude), long-term stable calibration, compact design, and performance with minimal maintenance for semi-continuous and continuous monitoring capabilities. The results from our preliminary investigations on the development of the TOC monitor are presented. Author

#### A90-49388\* Houston Univ., TX.

### INFLUENCE OF IODINE ON THE TREATMENT OF SPACECRAFT HUMIDITY CONDENSATE TO PRODUCE POTABLE WATER

JAMES M. SYMONS (Houston, University, TX) and SUSAN V. MUCKLE SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 25 p. (Contract NAG9-284)

(SAE PAPER 901355) Copyright

Several compounds in the ersatz humidity condensate do react with iodine to form iodine-substituted organic compounds (TOI), most notably phenol, acetaldehyde, ethanol, and sodium formate. Iodination of the ersatz humidity condensate produced 3.0 to 3.5 mg/L of TOI within 24 hours. The TOI that was produced by the passage of the ersatz humidity condensate through the first iodinated resin (IR) in the adsorption system was removed by the granular activated carbon that followed. TOI detected in the final effluent was formed by the reaction of the non-adsorbable condensate compounds with the final IR in the treatment series. The activated carbon bed series in the adsorption system performed poorly in its removal of TOC. The rapid breakthrough of TOC was not surprising, as the ersatz humidity condensate contained several highly soluble organic compounds, alcohols and organic acids. Author

# A90-49389\* Krug International, Houston, TX.

# RECENT EXPERIENCES WITH IODINE WATER DISINFECTION IN SHUTTLE

RANDALL E. GIBBONS, DAVID T. FLANAGAN, JOHN R. SCHULTZ (Krug International, Houston, TX), RICHARD L. SAUER, and TERRY N. SLEZAK (NASA, Johnson Space Center, Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 13 p. refs

(SAE PAPER 901356) Copyright

Microbial proliferation in the STS potable water system is prevented by maintaining a 2-5 ppm iodine residual. The iodine is added to fuel cell water by an iodinated ion exchange resin in the Microbial Check Valve (MCV). Crew comments indicated excessive iodine in the potable water. To better define the problem, a method of in-flight iodine analysis was developed. Inflight analysis during STS-30 and STS-28 indicated iodine residuals were generally in the 9-13 ppm range. It was determined that the high iodine residual was caused by MCV influent temperatures in excess of 120 F. This is well above the MCV operating range of 65-90 F. The solution to this problem was to develop a resin suitable for the higher temperatures. Since 8 months were required to formulate a MCV resin suitable for the higher temperatures, a temporary solution was necessary. Two additional MCV's were installed on the chilled and ambient water lines leading into the galley to remove the excess iodine. These reduced the iodine residual to 3-4 ppm during STS-33, STS-34, STS-36 and STS-32. A high-temperature resin was formulated and initially flown on STS-31. Author

A90-49390\* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX. REACH PERFORMANCE WHILE WEARING THE SPACE

#### REACH PERFORMANCE WHILE WEARING THE SPACE SHUTTLE LAUNCH AND ENTRY SUIT DURING EXPOSURE TO LAUNCH ACCELERATIONS

JAMES P. BAGIAN, M. C. GREENISEN (NASA, Johnson Space Center, Houston, TX), L. E. SCHAFER, J. D. PROBE (Lockheed Engineering and Sciences Co., Houston, TX), and ROBERT W. KRUTZ, JR. (Krug International, San Antonio; USAF, School of Aerospace Medicine, Brooks AFB, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 7 p.

#### (SAE PAPER 901357) Copyright

A crew of four veteran astronaut/pilots were subjected to sustained linear accelerations of up to 3G(x) in order to quantify crew reach performance while wearing the currently used Launch and Entry Suit (LES). Photogrammetric techniques were used to quantify magnitudes of reach in any direction while subjects rode a centrifuge. Subjects exhibited small changes of reach capability in the +x (forward) direction which ranged from an improvement of 2.04 cm to a decrease of 14.4 cm while reach performance in the +z (overhead) direction was improved in three of four subjects, indicating that any task which could be accomplished under exposure to 1G(x) could definitely be done at 3G(x). The data from this experiment demonstrated that Shuttle crews in training can expect to maintain all of the overhead reach capability evident in good simulator runs and suffer only moderate degradation in the forward reach performance during the launch phase of an actual Shuttle mission. L.K.S.

#### A90-49391\* Krug International, San Antonio, TX. HEART RATE AND PULMONARY FUNCTION WHILE WEARING THE LAUNCH-ENTRY CREW ESCAPE SUIT (LES) DURING + GX ACCELERATION AND SIMULATED SHUTTLE LAUNCH

ROBERT W. KRUTZ, JR. (Krug International, Life Sciences Div., San Antonio, TX), JAMES P. BAGIAN (NASA, Johnson Space Center, Houston, TX), RUSSELL R. BURTON, and LARRY J. MEEKER (USAF, School of Aerospace Medicine, Brooks AFB, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 5 p.

(Contract F33615-89-C-0603)

# (SAE PAPER 901358) Copyright

Space shuttle crewmembers have been equipped with a launch-entry crew escape system (LES) since the Challenger accident in 1986. Some crewmembers, wearing the new pressure suit, have reported breathing difficulties and increased effort to achieve the desired range of motion. This study was conducted to quantify the reported increased physical workloads and breathing difficulty associated with wearing the LES. Both veteran astronauts and centrifuge panel members were exposed to various + Gx profiles (including simulated shuttle launch) + Gx on the USAF School of Aerospace Medicine (USAFSAM) human-use centrifuge. Maximum heart rate data showed no increased workload associated with arm and head movement in the LES when compared to the flight suit/helmet ensemble (LEH). However, the LES did impose a significant increase in breathing difficulty beginning at +2.5 Gx which was demonstrated by a decrease in forced vital capacity and subjected questionnaries. Author

**A90-49393\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

#### SCIENTIFIC USES AND TECHNICAL IMPLEMENTATION OF A VARIABLE GRAVITY CENTRIFUGE ON SPACE STATION FREEDOM

C. C. JOHNSON and A. R. HARGENS (NASA, Ames Research Center, Moffett Field, CA) SAE, Intersociety Conference on

Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 11 p. refs

(SAE PAPER 901360) Copyright

The potential need and science requirements for a centrifuge to be designed and flown on Space Station Freedom are discussed, with a focus on a design concept for a centrifuge developed at NASA Ames. Applications identified for the centrifuge include fundamental studies in which gravity is a variable under experimental control, the need to provide a 1-g control, attempts to discover the threshold value of gravitation force for psychological response, and an effort to determine the effects of intermittent hypergravity. Science requirements specify the largest possible diameter at approximately 2.5 m, gravity levels ranging from 0.01 to 2 g, a nominal ramp-up rate of 0.01 g/sec, and life support for plants and animals. Ground-based studies using rats and squirrel monkeys on small-diameter centrifuges have demonstrated that animals can adapt to centrifugation at gravity gradients higher than those normally used in ground-based hypergravity studies.

L.K.S.

### **A90-49394\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

# AX-5 SPACE SUIT RELIABILITY MODEL

AL REINHARDT (NASA, Ames Research Center, Moffett Field, CA; USAF, Office of Scientific Research, Washington, DC) and JOHN MAGISTAD (San Jose State University, CA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 11 p. Research supported by USAF and San Jose State University. refs

(SAE PAPER 901361) Copyright

The AX-5 is an all metal Extra-vehicular (EVA) space suit currently under consideration for use on Space Station Freedom. A reliability model was developed based on the suit's unique design and on projected joint cycle requirements. Three AX-5 space suit component joints were cycled under simulated load conditions in accordance with NASA's advanced space suit evaluation plan. This paper will describe the reliability model developed, the results of the cycle testing, and an interpretation of the model and test results in terms of projected Mean Time Between Failure for the AX-5. A discussion of the maintenance implications and life cycle for the AX-5 based on this projection is also included. Author

#### A90-49400

# INTEGRATED AIR/WATER COOLING CONCEPTS FOR SPACE LABORATORY MODULES

G. SARRI, H. P. LEISEIFER, and B. PATTI (ESTEC, Noordwijk, Netherlands) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 12 p. refs (SAE PAPER 901370) Copyright

The Columbus Pressurized Module's air loop architecture is discussed vis a vis possible alternative solutions, taking the reconfiguration of air cooling loops and the water loop interfaces into account. It is noted that the thermal and environmental control of such permanently operating space laboratories in conjunction with the International Space Station Freedom would include enhanced crew size, power dissipation due to a broad range of experiments, flexibility with respect to payload reconfiguration, and rack interchangeability. These requirements and related conceptual design solutions are analyzed in the light of overall system aspects.

**A90-49407\*** National Aeronautics and Space Administration. John C. Stennis Space Center, Bay Saint Louis, MS.

#### ASSESSMENT OF INTERNAL CONTAMINATION PROBLEMS ASSOCIATED WITH BIOREGENERATIVE AIR/WATER PURIFICATION SYSTEMS

ANNE H. JOHNSON (NASA, Stennis Space Center, Bay Saint Louis, MS), B. KEITH BOUNDS, and WARREN GARDNER (NASA, Stennis Space Center; Sverdrup Technology, Inc., Bay Saint Louis, MS) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 8 p. refs (SAE PAPER 901379) Copyright

The emphasis is to characterize the mechanisms of

bioregenerative revitalization of air and water as well as to assess the possible risks associated with such a system in a closed environment. Marsh and aquatic plants are utilized for purposes of wastewater treatment as well as possible desalinization and demineralization. Foliage plants are also being screened for their ability to remove toxic organics from ambient air. Preliminary test results indicate that treated wastewater is typically of potable quality with numbers of pathogens such as Salmonella and Shigella significantly reduced by the artificial marsh system. Microbiological analyses of ambient air indicate the presence of bacilli as well as thermophilic actinomycetes. Author

#### A90-49408\* Kansas State Univ., Manhattan. APPLICATION OF THE PENTAIODIDE STRONG BASE RESIN DISINFECTANT TO THE U.S. SPACE PROGRAM

GEORGE L. MARCHIN (Kansas State University, Manhattan) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 7 p. Research supported by Hatch Fund. refs

(Contract NAGW-1197)

(SAE PAPER 901380) Copyright

A pentaiodide resin is described which has 70 percent of its weight composed of elemental iodine, has a relatively low iodine residual, and may offer superior disinfection capability for applications on long-duration space vehicles. Such a disinfectant is crucial for use on spacecraft for long periods of time where water would be recycled through various systems. The pentaiodide resin is capable of devitalizing 1 x 10 to the 9th bacteria per ml in aqueous suspension within 10 seconds of contact with the resin bed. A number of organisms have already been tested and the resin continues to prove effective. Resin properties and composition are discussed and a detailed account of the first investigation of the pentaiodide resin as a disinfectant against the intestinal parasite Giardia lamblia is provided. L.K.S.

#### A90-49410\* Krug International, Houston, TX.

SPACE STATION FREEDOM VIEWED AS A 'TIGHT BUILDING' THOMAS F. LIMERO, ROBERT D. TAYLOR (Krug International, Technology Life Sciences Div., Houston, TX), DUANE L. PIERSON, and JOHN T. JAMES (NASA, Johnson Space Center, Houston, Texas) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 19 p. refs

(SAE PAPER 901382) Copyright

The Space Station Freedom (SSF), with a 30-year projected lifetime and a completely closed-loop Environmental Control and Life Support System (ECLSS), is perhaps the ultimate 'tight building'. Recognizing the potential for the development of 'tight building syndrome' (TBS), and initiating actions to minimize possible TBS occurrences on SSF, requires a multidisciplinary approach that begins with appropriate design concerns and ends with detection and control measures on board SSF. This paper presents a brief summary of current experience with TBS on earth. Air contamination, including volatile organic compounds and microorganisms, is the focus of the discussion. Preventive steps to avoid TBS, control of environmental factors that may lead to TBS, and use of real-time instrumentation for the detection of potential causes of TBS are also outlined.

#### A90-49411\* Houston Univ., Clear Lake, TX. IDENTIFYING ATMOSPHERIC MONITORING NEEDS FOR SPACE STATION FREEDOM

DENNIS M. CASSERLY (Houston, University, TX) and DANE M. RUSSO (NASA, Johnson Space Center, Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 14 p. refs (Contract NGT-44-001-800)

# (SAE PAPER 901383) Copyright

The monitoring needs for Space Station Freedom were identified by examining: the experiences of past missions; ground based tests of proposed life support systems; a contaminant load model; metabolic production from an 8-person crew; and a fire scenario. Continuous monitoring is recommended for components critical for life support, and that intermittent analysis be provided for all agents that may exceed one-half the spacecraft maximum allowable concentration. The minimum monitoring effort recommended includes continuous monitoring for: N2, O2, CO2, CO, H2O, H2, CH4, nonmethane hydrocarbons, aromatic hydrocarbons, refrigerants, and halons. Information on over 70 compounds is presented on the rationale for monitoring the frequency of analysis, and concentration ranges. Author

#### A90-49412

#### **CRITICAL TECHNOLOGIES - SPACECRAFT HABITABILITY**

R. A. J. DAMS (CJB Developments, Inc., Portsmouth, England) and C. SOULEZ-LARIVIERE (ESTEC, Noordwijk, Netherlands) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 10 p.

(SAE PAPER 901384) Copyright`

A study for the European Space Agency (ESA) identifies critical technologies (CT) relating to spacecraft habitability, where CT are defined as technologies requiring a solution in order that the objectives of the European Manned Space Infrastructure (EMSI) can be met. The study lists 36 CTs and provides comparative timescales and costs for development programs to find solutions. Topics include food, clothing, hygiene and architecture and critical technologies for these topics include such things as a trash compactor, clothes washing procedures, oral hygiene, and body and foot restraints. It is noted that in order to implement these development programs, an overall habitability strategy will be required.

### A90-49413

#### ALTERNATIVE HYGIENE CONCEPTS

JACQUELINE BAUNE (MBB-ERNO Raumfahrttechnik GmbH, Bremen, Federal Republic of Germany) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 8 p. refs

(SAE PAPER 901385) Copyright

Hygiene alternatives that may be applicable to manned space flights are explored. It is proposed that overall body hygiene be based on exfoliation, which would be achieved through dry body brushing with 30 to 100 brush strokes deemed to be necessary. Focus is placed on development of the Environment and Life Support System capable of trapping and filtering the extoliated debris and hair. As far as oral hygiene, a diet of sugar-free and nonrefined food rich in wholefoods, dairy products, and drinks containing polyphenols would reduce the need for current forms of oral hygiene practices. The use of a fecal bag made of rubber materials similar to condoms is suggested for collecting feces. The interrelationships of the various aspects of an alternative diet/hygiene/waste-management system are illustrated, and an implementation process consisting of system design and development, preflight mission preparation, and activities performed during the mission is outlined with emphasis on crew acceptability. V.T.

#### A90-49414

### HYGIENE AND WATER IN SPACE STATION

J. COLLET, A. BICHI (ESA, Paris, France), J. C. GERMAIN, J. M. BARREAU, E. KIHM (Matra Espace, Velizy-Villacoublay, France) et al. SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 15 p. refs (SAE PAPER 901386) Copyright

A study on hygiene in long duration space missions was held between 1988-1989 for the ESA Long Term Programme Office. The impact of hygiene on station contamination and station layout was reviewed as well as psychological, social and cultural aspects, leading to the conclusion that hygiene is a key habitability issue. Among its main results, the study highlighted the importance of water in both environmental and personal hygiene. Due to the limited water availability in Space Stations, particular attention was paid to on board water management. Simulation software was developed to demonstrate the relation between hygiene subsystems concepts and water requirements. Author

#### A90-49415 EUROPEAN SPACE STATION HEALTH CARE SYSTEM CONCEPT

ROLF JESSL (MBB-ERNO Raumfahrttechnik GmbH, Bremen, Federal Republic of Germany) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 10 p.

### (SAE PAPER 901387) Copyright

Results of a health risk analysis and the follow-on derivation of medical requirements for crews of the European Space Station are presented. Details are provided for health risk assessment, medical equipment definition, and health care system design. The health care system will consist of an onboard escape vehicle and ground based equipment to prevent accidents and sickness by maintaining and monitoring crew health, and providing a safety margin by stabilizing sick or injured crew before and during transfer to earth. R.E.P.

### A90-49416

# HABITABILITY STUDIES FOR HERMES - A STATUS OF SIMULATION AND VALIDATION

F. WINISDOERFFER (Aerospatiale, Division Systemes Strategiques et Spatiaux, Les Mureaux, France) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 14 p. refs

(Contract CNES-88-5400)

(SAE PAPER 901388) Copyright

The Hermes program has been adopted as an European program at The Hague ministerial level meeting in 1987. The primary mission of Hermes will be the servicing of the Columbus Free Flyer Laboratory. A typical mission will last 10 to 12 days and will be based on the utilization of the three crewmembers on board. A satisfactory environment is essential to support crew physical, physiological and psychological needs in order to promote mission success. This paper will present, in a first part, a description of the baseline configuration of the space vehicle, and in a second part, the preliminary verification of the adequacy of the internal layout with the users, using CAD simulations of the crewmembers activities, and then, a full scale mock-up which was build to validate those simulations and to ensure the overall coherence of the composite Hermes/Columbus Free Flyer.

#### A90-49417

#### HERMES-CREW INTEGRATION ASPECTS

G. BOLSTAD, B. BENUM, A. O. BRUBAKK, P. DEFRANCISCO (Selskapet for Industriell og Teknisk Forskning, Trondheim, Netherlands), M. KHINE (ESA, Toulouse, France) et al. SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 6 p. refs

(SAE PAPER 901390) Copyright

Crew integration requirements for the Hermes spaceplane are considered, including crew accommodation, crew life management, and crew safety. Anthropometry, biomechanics, and humanperformance aspects are discussed, and emphasis is placed human-system, human-machine, and human-computer on interfaces. Requirements on systems, equipment, and tasks involving joint motion, reach, grasp, neutral body posture, center of gravity, moments of inertia, body surface, volume, and mass, and visual field and strength are assessed. Focus placed on the definition of an optimum work envelope affected by microgravity conditions. Requirements directed toward the natural and induced environment, covering atmosphere, acceleration, acoustics, and vibration, are analyzed. Attention is drawn to health management, food services, clothing, and hygiene and waste management. Crew-operations support requirements and crew safeguards and protection are outlined. VТ

A90-49418\* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX. SPACE STATION FREEDOM CONTAMINATION REQUIREMENTS AND PREDICTIONS

HORST K. F. EHLERS (NASA, Johnson Space Center, Houston,

 SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 11 p. (SAE PAPER 901408) Copyright

Space Station Freedom (SSF) requirements for the induced external gaseous and particulate environment have been defined. They include the Assembly Complete (AC) and the Permanently Manned Capability (PMC) phases which were established since the original configuration was developed. Requirements for both SSF configurations are discussed. Preliminary assessments of the impacts on SSF design and operation indicate that these requirements are both realistic and acceptable to the users with

#### A90-49423

attached payloads.

# IVA AND EVA WORK PLACE DESIGN FOR A MAN-TENDED SYSTEM

MANFRED BAUNE (MBB-ERNO Raumfahrttechnik GmbH, Bremen, Federal Republic of Germany) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 17 p.

(SAE PAPER 901415) Copyright

This paper considers global and detailed design responses to the particular problems of a non-space adapted crew. It discusses crew disorientation problems and the space adaptation syndrome as they relate to certain design features of a prospective, man-tended vehicle. Both IVA and EVA scenarios and related design characteristics are addressed along with architectural and functional needs and implementation potentials. The paper notes some associated technological details such as, e.g., the need for matching the design of modern electronic units with the dimensional capabilities of module racks, or the use of a particular type of connectors to enhance EVA. An EVA and repair philosophy in response to crew capabilities and problems is also proposed.

Author

Author

#### A90-49424

# HABEMSI STUDY - A STUDY ON HUMAN FACTORS FOR SPACE STATION DESIGN

L. BASILE (Aeritalia S.p.A., Naples, Italy), J. P. MAYER (AMDBA, S.A., Vaucresson, France), and A. LINDENTHAL (Dornier GmbH, Friedrichshafen, Federal Republic of Germany) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 10 p.

(SAE PAPER 901416) Copyright

A preparatory program for the European Manned Space Infrastructure (EMSI) is presented. The EMSI system evolution, human factors analyses, habitation-module configuration evolution. and simulation programs and facilities are discussed. Four phases in the evolution process are identified from the initial step of the implementation of the European Space Station (ESS) in a man-tended mode to a permanently-manned facility. Human abilities, limitations, and performance affecting design considerations for systems, tasks, jobs, and environments for safe, comfortable, and effective human use are assessed. The habitation-module configuration selected on the basis of several trade-offs is described, and such crew functions as sleeping, eating, personal hygiene, waste management, clothing, communication, housekeeping, health management, exercise, and recreation are outlined. Attention is given to neutral buoyancy facilities on the ground, microgravity conditions on orbit, and the NASA program Health Radiation Initiative as a tool related to interplanetary space missions to Mars. V.T.

#### A90-49425

# COMMON APPROACH FOR PLANETARY HABITATION SYSTEMS IMPLEMENTATION

FRANK STEINSIEK and UWE APEL (MBB-ERNO Raumfahrttechnik GmbH, Bremen, Federal Republic of Germany) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 12 p. refs

(SAE PAPER 901417) Copyright

The European philosphy for the establishment of man's presence in space is defined by ESA's European Manned Space

Infrastructure Programme (EMSI). The development toward a European manned space station is defined by discrete steps on manned capabilities and technology applications. Different. alternative evolutionary approaches toward a European space station and key elements have been studied by industry within the last years. Potential orbital scenarios, the habitation module, interconnecting element and escape vehicle were major themes of investigations. The purpose of this paper is to provide possible concepts for orbital, lunar and martian habitats, based on the recent study results and ESA's EMSI-philosophy. Advanced habitability conceptual designs concerning crew comfort and human factors, resources supply and different utilization aspects will be outlined, pending on the environmental characteristics of the operation sides: on moon, Mars or in low earth orbit. Key issues of these hab-system developments in terms of technology needs, operational characteristics and aspects of an international cooperation and European industrial potential are discussed.

Author

# A90-49426

# SPACECRAFT ACCOMMODATION STRATEGIES FOR MANNED MARS MISSIONS

DAVID NIXON and JAN KAPLICKY SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 8 p. refs

(SAE PAPER 901418) Copyright

Several strategies for improving spacecraft accommodation habitability for manned Mars missions are discussed, with focus placed on the maximum architectural opportunity attainable with the minimum pressurized volume. Increase in internal spaciousness by inflight modifications recovering residual volume from other completed applications is considered, along with improvements in accommodation efficiency by adaptation to changes in shifts and schedules, optimization of the sleeping quarters and exercise facilities as deployable and expandable compartments, development of the inflight training facilities serving a dual purpose as a semiprivate crew library, and the use of inflatable pressurized structures providing an exterior annexed accommodation capability similar to those identified by NASA for constructible habitats on the surface of the moon.

**A90-49428\*** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

# REQUIREMENTS FOR EXTRAVEHICULAR ACTIVITIES ON THE LUNAR AND MARTIAN SURFACES

MARIANN F. BROWN and SUSAN M. SCHENTRUP (NASA, Johnson Space Center, Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 11 p. refs

(SAE PAPER 901427) Copyright

Basic design reference requirements pertinent to EVA equipment on lunar and martian surfaces are provided. Environmental factors affecting surface EVA are analyzed including gravity, dust, atmospheric conditions, thermal gradients, lightning conditions, and radiation effects, and activities associated with surface EVA are outlined. Environmental and activity effects on EVA equipment are assessed, and emphasis is placed on planetary surface portable life support systems (PLSS), suit development, protection from micrometeoroids, dust, and radiation, food and water supplies, and the extravehicular mobility-unit thermal-control system. Environmental and activity impacts on PLSS design are studied, with focus on base self-sufficiency and reduction in resupply logistics.

A90-49429\* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX. DESIGN CONSIDERATIONS FOR FUTURE PLANETARY SPACE SUITS

JOSEPH J. KOSMO (NASA, Johnson Space Center, Houston, TX) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 12 p. refs

(SAE PAPER 901428) Copyright

Manned extravehicular activity (EVA) operations will be major

### 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

mission elements of planned future U.S. space operations. Whether designed for orbital operations or planetary surface exploration, the EVA system must be safe and reliable, and must provide a high degree of performance capabilities. An extravehicular mobility unit (EMU) consisting of a space suit, EVA gloves, and a portable life support system (PLSS) is central to the EVA system. A rugged, highly reliable, mobile, reusable, and easily maintained EVA suit and compact PLSS must meet the specific requirements of the intended mission. Additional requirements imposed by exposure to surface and gravitational environments are the need for lightweight, high-strength materials for fabricating EMUs to prevent astronaut fatigue and the need for dust protection measures and removal techniques to prevent contamination. Also, operational pressure for habitats should be chosen so as to maintain zero-prebreathe conditions while allowing for lower EMU operating pressure. Author

**A90-49430\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

#### A METHODOLOGY FOR CHOOSING CANDIDATE MATERIALS FOR THE FABRICATION OF PLANETARY SPACE SUIT STRUCTURES

GILDA JACOBS (NASA, Ames Research Center; Sterling Software, Inc., Moffett Field, CA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 9 p. refs

(SAE PAPER 901429) Copyright

A study of space suit structures and materials is under way at NASA Ames Research Center, Moffett Field, CA. The study was initiated by the need for a generation of lightweight space suits to be used in future planetary Exploration Missions. This paper provides a brief description of the Lunar and Mars environments and reviews what has been done in the past in the design and development of fabric, metal, and composite suit components in order to establish criteria for comparison of promising candidate materials and space suit structures. Environmental factors and mission scenarios will present challenging material and structural requirements; thus, a program is planned to outline the methodology used to identify materials and processes for producing candidate space suit structures which meet those requirements. Author

### A90-49433\* Allied-Signal Aerospace Co., Torrance, CA. AN AIR BEARING FAN FOR EVA SUIT VENTILATION

ROGER P. MURRY (Allied-Signal Aerospace Co., Torrance, CA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 8 p. Research supported by NASA.

(SAE PAPER 901432) Copyright

The portable life-support system (PLSS) ventilation requirements are outlined, along with the application of a high-speed axial fan technology for extravehicular-activity (EVA) space-suit ventilation. Focus is placed on a mechanical design employing high-speed gas bearings, permanent magnet rotor, and current-fed chopper/inverter electronics. The operational characteristics of the fan unit and its applicability for use in a pure-oxygen environment are discussed. It delivers a nominal 0.17 cu m/min at 1.24 kPa pressure rise using 13.8 w of input power. It is shown that the overall selection of materials for all major component meets the NASA requirements.

**A90-49434\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

# A DIRECT-INTERFACE FUSIBLE HEAT SINK FOR ASTRONAUT COOLING

CURTIS LOMAX and B. W. WEBBON (NASA, Ames Research Center, Moffett Field, CA) SAE, Intersociety Conference on Environmental Systems, 20th, Williamsburg, VA, July 9-12, 1990. 14 p. Previously announced in STAR as N90-25292. refs (SAE PAPER 901433) Copyright

Astronaut cooling during extravehicular activity is a critical design issue in developing a portable life support system that meets the requirements of a space station mission. Some the requirements are that the cooling device can be easily regenerable

and nonventing during operation. In response to this, a direct-interface, fusible heat sink prototype with freezable quick-disconnects was developed. A proof-of-concept prototype was constructed and tested that consists of an elastic container filled with normal tap water and having two quick-disconnects embedded in a wall. These quick-disconnects are designed so that they may be frozen with the ice and yet still be joined to the cooling system, allowing an immediate flow path. The inherent difficulties in a direct-interface heat sink have been overcome, i.e., (1) establishing an initial flow path; (2) avoiding low-flow freeze-up; and (3) achieving adequate heat-transfer rates at the end of the melting process. The requirements, design, fabrication, and testing are discussed.

**N90-27261\*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

# ROTATIONALLY ACTUATED PROSTHETIC HELPING HAND Patent Application

WILLIAM E. NORTON, inventor (to NASA), JEWELL G. BELCHER, JR., inventor (to NASA), JAMES R. CARDEN, inventor (to NASA), and THOMAS W. VEST, inventor (to NASA) (Membrane Systems, Inc., San Diego, CA.) 12 Apr. 1990 14 p

(NASA-CASE-MFS-28426-1; NAS 1.71:MFS-28426-1;

US-PATENT-APPL-SN-508154) Avail: NTIS HC A03/MF A01 CSCL 05/8

A prosthetic device for below-the-elbow amputees having a cuff, a stem, a housing, two hook-like fingers, an elastic band for holding the fingers together, and a brace, is disclosed. The fingers upper arm with the brace. The stem, which also contains a cam, is rotationally mounted within the housing and is secured to the cuff, which fits over the amputee's stump. By rotating the cammed stem between the fingers. NASA

N90-27262# North Carolina Univ., Chapel Hill. Dept. of Computer Science.

# A REAL-TIME OPTICAL 6D TRACKER FOR HEAD-MOUNTED DISPLAY SYSTEMS Ph.D. Thesis

JIH-FANG WANG Mar. 1990 99 p

(Contract N00014-86-K-0680)

(AD-A222884; TR90-011) Ávail: NTIS HC A05/MF A01 CSCL 17/11

Significant advance has been made towards realistic synthesis and display of 3-D objects using computers during the past two decades. However, the interaction between human and computer generated scenes remains largely remote through devices such as keyboards, mice, joysticks, etc. Head mounted display provides a mechanism for much more realistic visualizing and interacting with computer generated 3D scenes through the hand-eye-body coordination exercised daily. Head mounted display systems require that the position and orientation of the user's head be tracked in real time with high accuracy in a large working environment. Current 6D positional tracking devices (3 translational and 3 rotational parameters) fail to satisfy these requirements. A new system for real time, 6-D position tracking is introduced, studied, and documented. This system adopts an inside-out tracking paradigm. The working environment is a room in which the ceiling is lined with a regular pattern of infrared LED beacons which are flashing (invisible to the human eyes) under the system's control. Three cameras are mounted on a helmet which the user wears. Each camera uses a lateral effect photodiode as the recording surface. The 2D image positions of the flashing beacons inside the field of view of the cameras are recorded and reported in real time. The measured 2D image positions and the known 3D positions of beacons are used to compute the position of the camera assembly in space. GRA

**N90-27263#** Army Aeromedical Research Lab., Fort Rucker, AL. Sensory Research Div.

HUMAN FACTORS AND SAFETY CONSIDERATIONS OF NIGHT VISION SYSTEMS FLIGHT USING THERMAL IMAGING SYSTEMS Final Report CLARENCE E. RASH, ROBERT W. VERONA, and JOHN S. CROWLEY (Army Safety Center, Fort Rucker, AL.) Apr. 1990 33 p Repr. from 1990 Technical Symposium on Aerospace Sensing (SPIE), 16-20 Apr. 1990 Submitted for publication (Contract DA PROJ. 3M1-62787-A-879)

(AD-A223226; USAARL-90-10) Avail: NTIS HC A03/MF A01 CSCL 20/6

Military aviation night vision systems enhance the aviator's capability to operate effectively during periods of low illumination, adverse weather, and in the presence of obscurants. Current fielded systems allow aviators to conduct terrain flight during conditions which would be extremely dangerous, if not impossible, using only unaided vision. In night vision systems, trade-offs are made that enhance some visual parameters and compromise others. Examples of visual parameters which are traded off include acuity, field-of-view, spectral sensitivity, and depth perception. Cost, weight, and size constraints also lead to compromises between the ideal and a viable system design, Thermal imaging sensors introduce enhanced night vision capabilities along with new problems associated with the interpretation of visual information based on spectral and spatial characteristics differing from those provided by unaided vision. GRA

N90-27264# Virginia Commonwealth Univ., Richmond. Dept. of Occupational Therapy.

# THE RELATIONSHIP OF ISOMETRIC GRIP STRENGTH, OPTIMAL DYNAMOMETER SETTINGS, AND CERTAIN ANTHROPOMETRIC FACTORS M.S. Thesis

MICHAEL SCOT REITH May 1990 139 p Sponsored by AFIT, Wright-Patterson AFB, OH

(AD-A222046; AFIT/CI/CIA-90-020) Avail: NTIS HC A07/MF A01 CSCL 23/2

A study was conducted to determine: (1) the relationships between isometric grip strength and eight anthropometric dimensions of the upper extremity, (2) the relationship between isometric grip strength and handle position of the Jamar dynamometer, and (3) a means of predicting optimal positioning of the Jamar dynamometer handle. Measurements were taken from 30 females between the ages of 21 and 25. Data were analyzed by means of the Pearson product-moment correlation, ANOVA and multiple ANOVA, predictive discrimination, and multiple regression. Significant correlations (p less than .05) existed between all dimensions of the hand and grip strength in all handle positions except the smallest, ranging from .36 to .61. Analysis of variance demonstrated significant differences between strength at the different handle positions. The results support the use of position two or three of the Jamar dynamometer handle for testing of maximum grip strength. Specific adjustment of the dynamometer handle seems unnecessary, but if desired it should be based upon hand length or length of the long digit. No anthropometric dimension appears to be strong enough to predict grip strength. GRA

**N90-27265#** Carnegie-Mellon Univ., Pittsburgh, PA. Dept. of Psychology.

## RÚLE ACQUISITION EVENTS IN THE DISCOVERY OF PROBLEM SOLVING STRATEGIES Final Technical Report, 1 Jan. 1988 - 31 Dec. 1990

KURT A. VANLEHN Jul. 1989 60 p Submitted for publication (Contract N00014-88-K-0086; N00014-86-K-0678) (AD-A222428; PCG-17) Avail: NTIS HC A04/MF A01 CSCL

(AD-A222420, FCG-17) AVail. NTIS HC A047 MF A0 05/8

Although there are many machine learning programs that can acquire new problem solving strategies, we do not know exactly how their processes will manifest themselves in human behavior, if at all. In order to find out, a line-by-line protocol analysis was conducted of a subject discovering problem solving strategies. A model was developed that could explain 96 percent of the lines in the procol. On this analysis, the subject's learning was confined to 11 rule acquisition events, wherein she temporarily abandoned her normal problem solving and focused on improving her strategic knowledge. Further analysis showed that: (1) Not rule acquisition events are triggered by impasses. (2) Rules are acquired gradually, both because of competition between new and old rules, and

because of the subject's apparently deliberate policy of gradual generalization. (3) This subject took a scientific approach to strategy discovery, even planning and conducting small experiments.

GRA

N90-27266# North Carolina Univ., Chapel Hill. Dept. of Computer Science.

#### TRACKING A HEAD-MOUNTED DISPLAY IN A ROOM-SIZED ENVIRONMENT WITH HEAD-MOUNTED CAMERAS

JIH-FANG WANG, RONALD AZUMA, GARY BISHOP, VERNON CHI, JOHN EYLES, and HENRY FUCHS 1990 11 p Presented at the 1990 Technical Symposium on Optical Engineering and Photonics in Aerospace Sensing, Orlando, FL, Apr. 1990 Submitted for publication

(Contract N00014-86-K-0680; NIH-RR-02170)

(AD-A222545) Avail: NTIS HC A03/MF A01 CSCL 17/5

This paper presents our efforts to accurately track a Head Mounted Display (HMD) in a large environment. We review our current benchtop prototype (introduced in (WCF90)), then describe our plans for building the full-scale system. Both systems use an inside-out optical tracking scheme, where lateral-effect photodiodes mounted on the user's helmet view flashing infrared beacons placed in the environment. Church's method uses the measured 2D image positions and the known 3D beacon locations to recover the 3D position and orientation of the helmet in real-time. We discuss the implementation and performance of the benchtop prototype. The full-scale system design includes ceiling panels that hold the infrared beacons and a new sensor arrangement of two photodiodes with holographic lenses. In the full-scale system, the user can walk almost anywhere under the grid of ceiling panels, making the working volume nearly as large as the room. GRA

# N90-27267# Anacapa Sciences, Inc., Fort Rucker, AL. HUMAN FACTORS RESEARCH IN AIRCREW PERFORMANCE AND TRAINING Final Report, Oct. 1988 - Oct. 1989

MICHAEL MCANULTY, ed. Mar. 1990 146 p (Contract MDA903-87-C-0523)

(AD-A221657; ASI690-326-89; ARI-TR-884) Avail: NTIS HC A07/MF A01 CSCL 01/1

Summary descriptions are presented emerging aviation weapon systems design, manpower and personnel programs, aviator training, and aviation safety research. The summary description for each project and technical advisory service contains a background section that describes the rationale for the project and specifies the research objectives; a research approach section that describes the tasks and activities required to meet the project objectives; a research findings section or, in the case of developmental activities, a research products section; and a project status section that describes projections for future research.

GRA

# N90-27276\*# Boeing Co., Huntsville, AL.

# AGENT INDEPENDENT TASK PLANNING

In NASA, Marshall Space Flight Center, WILLIAM S. DAVIS Fifth Conference on Artificial Intelligence for Space Applications p 1-10 May 1990

Avail: NTIS HC A25/MF A04 CSCL 05/8

Agent-Independent Planning is a technique that allows the construction of activity plans without regard to the agent that will perform them. Once generated, a plan is then validated and translated into instructions for a particular agent, whether a robot, crewmember, or software-based control system. Because Space Station Freedom (SSF) is planned for orbital operations for approximately thirty years, it will almost certainly experience numerous enhancements and upgrades, including upgrades in robotic manipulators. Agent-Independent Planning provides the capability to construct plans for SSF operations, independent of specific robotic systems, by combining techniques of object oriented modeling, nonlinear planning and temporal logic. Since a plan is validated using the physical and functional models of a particular agent, new robotic systems can be developed and integrated with existing operations in a robust manner. This technique also provides the capability to generate plans for crewmembers with varying skill levels, and later apply these same plans to more sophisticated robotic manipulators made available by evolutions in technology. Author

N90-27294\*# Vanderbilt Univ., Nashville, TN.

A STUDY ON DIAGNOSABILITY OF SPACE STATION ECLSS S. PADALKAR, W. BLOKLAND, and J. SZTIPANOVITS In NASA, Marshall Space Flight Center, Fifth Conference on Artificial Intelligence for Space Applications p 165-174 May 1990 Sponsored in part by Boeing Aerospace Co., Huntsville, AL Avail: NTIS HC A25/MF A04 CSCL 06/11

The use is demonstrated of the Multigraph Architecture (MGA) for studies on the Environment Control and Life Support System (ECLSS). The objective was the following: (1) to create an updated set of models of the Potable Water Subsystem (PWS) by using the graphical model building tools of the Multigraph Programming Environment (MPE); (2) to derive a real time alarm simulator from the models; and (3) to demonstrate the effects of sensor allocation on the diagnosability of the PWS. This work may serve as a preliminary study for the detailed analysis of the sensor allocation and diagnosability problems in the ECLSS. Author

N90-27297\*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL. SPACE STATION FREEDOM ECLSS: A STEP TOWARD AUTONOMOUS REGENERATIVE LIFE SUPPORT SYSTEMS BRANDON S. DEWBERRY In its Fifth Conference on Artificial Intelligence for Space Applications p 193-201 May 1990

Avail: NTIS HC A25/MF A04 CSCL 06/11 The Environmental Control and Life Support System (ECLSS) is a Freedom Station distributed system with inherent applicability to extensive automation primarily due to its comparatively long control system latencies. These allow longer contemplation times in which to form a more intelligent control strategy and to prevent and diagnose faults. The regenerative nature of the Space Station Freedom ECLSS will contribute closed loop complexities never before encountered in life support systems. A study to determine ECLSS automation approaches has been completed. The ECLSS baseline software and system processes could be augmented with more advanced fault management and regenerative control systems for a more autonomous evolutionary system, as well as serving as a firm foundation for future regenerative life support systems. Emerging advanced software technology and tools can be successfully applied to fault management, but a fully automated life support system will require research and development of regenerative control systems and models. The baseline Environmental Control and Life Support System utilizes ground tests in development of batch chemical and microbial control processes. Long duration regenerative life support systems will require more active chemical and microbial feedback control systems which, in turn, will require advancements in regenerative life support models and tools. These models can be verified using ground and on orbit life support test and operational data, and used in the engineering analysis of proposed intelligent instrumentation feedback and flexible process control technologies for future autonomous regenerative life support systems, including the evolutionary Space Station Freedom ECLSS. Author

National Aeronautics and Space Administration. N90-27298\*# Marshall Space Flight Center, Huntsville, AL.

## SIMULATION-BASED INTELLIGENT ROBOTIC AGENT FOR SPACE STATION FREEDOM

CSABA A. BIEGL, JAMES F. SPRINGFIELD, GEORGE E. COOK. and KENNETH R. FERNANDEZ (Vanderbilt Univ., Nashville, TN.) In its Fifth Conference on Artificial Intelligence for Space Applications p 203-210 · May 1990 Avail: NTIS HC A25/MF A04 CSCL 05/8

A robot control package is described which utilizes on-line structural simulation of robot manipulators and objects in their workspace. The model-based controller is interfaced with a high level agent-independent planner, which is responsible for the task-level planning of the robot's actions. Commands received

from the agent-independent planner are refined and executed in the simulated workspace, and upon successful completion, they are transferred to the real manipulators. Author

N90-27303\*# Mitre Corp., McLean, VA. Artificial Intelligence Technical Center.

# CREATURE CO-OP: ACHIEVING ROBUST REMOTE

OPERATIONS WITH A COMMUNITY OF LOW-COST ROBOTS

R. PETER BONASSO *In* NASA, Marshall Space Flight Center, Fifth Conference on Artificial Intelligence for Space Applications p 257-269 May 1990

Avail: NTIS HC A25/MF A04 CSCL 05/8

The concept is advanced of carrying out space based remote missions using a cooperative of low cost robot specialists rather than monolithic, multipurpose systems. A simulation is described wherein a control architecture for such a system of specialists is being investigated. Early results show such co-ops to be robust in the face of unforeseen circumstances. Descriptions of the platforms and sensors modeled and the beacon and retriever creatures that make up the co-op are included. Author

**N90-27311\***# Boeing Aerospace Co., Huntsville, AL. Advanced Civil Space Systems.

## A VISION-BASED TELEROBOTIC CONTROL STATION

BRIAN TILLOTSON *In* NASA, Marshall Space Flight Center, Fifth Conference on Artificial Intelligence for Space Applications p 325-329 May 1990

Avail: NTIS HC A25/MF A04 CSCL 05/8

A telerobotic control station is described. In it, a machine vision system measures the position, orientation, and configuration of a user's hand. A robotic manipulator mirrors the status of the hand. This concept has two benefits: control actions are intuitive and easily learned, and the workstation requires little volume or mass.

Author

**N90-27314\*#** Rockwell International Corp., Downey, CA. Space Transportation Systems Div.

# A MODEL FOR A SPACE SHUTTLE SAFING AND FAILURE-DETECTION EXPERT

DAPHNA ZEILINGOLD and JOHN HOEY In NASA, Marshall Space Flight Center, Fifth Conference on Artificial Intelligence for Space Applications p 351-359 May 1990

Avail: NTIS HC A25/MF A04 CSCL 06/11

The safing and failure-detection expert (SAFE) is a prototype for a malfunction detection, diagnosis, and safing system for the atmospheric revitalization subsystem (ARS) in the Space Shuttle SAFE, whose knowledge extracted orbiter. was from expert-provided heuristics and documented procedures, automatically manages all phases of failure handling: detection, diagnosis, testing procedures, and recovery instructions. The SAFE architecture allows it to handle correctly sensor failures and multiple malfunctions. Since SAFE is highly interactive, it was used as a test bed for the evaluation of various advanced human-computer interface (HCI) techniques. The use of such expert systems in the next generation of space vehicles would increase their reliability and autonomy to levels not achievable before. Author

N90-27331\*# Alabama A & M Univ., Normal. Dept. of Computer and Information Sciences.

## RESOLUTION OF SEVEN-AXIS MANIPULATOR REDUNDANCY: A HEURISTIC ISSUE

I. CHEN *In* NASA, Marshall Space Flight Center, Fifth Conference on Artificial Intelligence for Space Applications p 535-543 May 1990

#### (Contract NAG8-023)

Avail: NTIS HC A25/MF A04 CSCL 05/8

An approach is presented for the resolution of the redundancy of a seven-axis manipulator arm from the AI and expert systems point of view. This approach is heuristic, analytical, and globally resolves the redundancy at the position level. When compared with other approaches, this approach has several improved performance capabilities, including singularity avoidance, repeatability, stability, and simplicity. Author **N90-27333\*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

# ROBOT DYNAMICS IN REDUCED GRAVITY ENVIRONMENT

GARY L. WORKMAN, TOLLIE GRISHAM (Alabama Univ:, Huntsville.), ELAINE HINMAN, and CINDY COKER *In its* Fifth Conference on Artificial Intelligence for Space Applications p 551-556 May 1990

Avail: NTIS HC A25/MF A04 CSCL 05/8

Robot dynamics and control will become an important issue for productive platforms in space. Robotic operations will be necessary for both man tended stations and for the efficient performance of routine operations in a manned platform. The current constraints on the use of robotic devices in a microgravity environment appears to be due to safety concerns and an anticipated increase in acceleration levels due to manipulator motion. The robot used for the initial studies was a UMI RTX robot, which was adapted to operate in a materials processing workcell to simulate sample changing in a microgravity environment. The robotic cell was flown several times on the KC-135 aircraft at Ellington Field. The primary objective of the initial flights was to determine operating characteristics of both the robot and the operator in the variable gravity of the KC-135 during parabolic maneuvers. It was demonstrated that the KC-135 aircraft can be used for observing dynamics of robotic manipulators. The difficulties associated with humans performing teleoperation tasks during varying G levels were also observed and can provide insight into some areas in which the use of artificial techniques would provide improved system performance. Additionally a graphic simulation of the workcell was developed on a Silicon Graphics Workstation using the IGRIP simulation language from Deneb Robotics. The simulation is intended to be used for predictive displays of the robot operating on the aircraft. It is also anticipated that this simulation can be useful for off-line programming of tasks in the future. Author

**N90-27767\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

#### THE DYNAMICS OF ORBITAL MANEUVERING: DESIGN AND EVALUATION OF A VISUAL DISPLAY AID FOR HUMAN CONTROLLERS

STEPHEN R. ELLIS (California Univ., Berkeley.) and ARTHUR J. GRUNWALD *In* AGARD, Space Vehicle Flight Mechanics 13 p Jun. 1990

Copyright Avail: NTIS HC A21/MF A03; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive CSCL 05/8

An interactive proximity operations planning system, which allows on-site planning of fuel-efficient, multi-burn maneuvers in a potential multi-spacecraft environment was developed and tested. Though this display system most directly assists planning by providing visual feedback to aid visualization of the trajectories and constraints, its most significant features include an inverse dynamics algorithm that removes control nonlinearities facing the operator and a trajectory planning technique that reduces the order of control and creates, through a geometric spread-sheet the illusion of an inertially stable environment. This synthetic environment provides the user with control of relevant static and dynamic properties of way-points during small orbital changes allowing independent solutions to the normally coupled problems of orbital maneuvering. An experiment was carried out in which experienced operators were required to plan a trajectory to retrieve an object accidently separated from a dual-keel space station. The time required to plan these maneuvers was found to be predicted by the direction of the insertion thrust and did not depend on the point of separation from the space station. Author

# **N90-28330** Department of the Navy, Washington, DC. **GARMENT PRESSURIZING APPARATUS Patent**

WALTER N. WERNER, inventor (to Navy), JEFFREY K. BISCARDI, inventor (to Navy), and EDWARD L. MCCLAIN, inventor (to Navy) 12 Dec. 1989 5 p Supersedes AD-D014147 Filed 30 Aug. 1988

## (AD-D014451; US-PATENT-4,885,930;

US-PATENT-APPL-SN-238675; US-PATENT-CLASS-73-37) Avail: US Patent and Trademark Office CSCL 14/2

Prior to pressurizing a garment at an opening therein, interior and exterior elements are drawn together along the longitudinal axis of a tube through which the pressurizing gas is applied, to grip the garment around the full periphery of that opening. In one particular embodiment, a means for monitoring pressure within the garment is included in the apparatus to provide for leak testing the garment after it is pressurized. GRA

N90-28331# National Inst. for Occupational Safety and Health, Cincinnati, OH. Div. of Standards Development and Technology Transfer.

# CRITERIA FOR A RECOMMENDED STANDARD:

OCCUPATIONAL EXPOSURE TO HAND-ARM VIBRATION AUSTIN HENSCHEL and VIRGINIA BEHRENS Sep. 1989 152 D

(PB90-168048; DHHS/PUB/NIOSH-89-106) Avail: NTIS HC A08/MF A01 CSCL 05/8

The occupational health problems associated with the use of vibrating tools (including both hand-held vibrating tools and stationary tools that transmit vibration through a workpiece) are examined, and criteria is provided for reducing the risk of developing vibration-induced health problems. The major health problems associated with the use of vibrating tools are signs and symptoms of peripheral vascular and peripheral neural disorders of the fingers and hands. These signs and symptoms include numbness, pain, and blanching of the fingers. This composite of vibration-induced signs and symptoms is referred to as hand-arm vibration syndrome (HAVS), sometimes called Raynaud's phenomenon of occupational origin, or vibration white finger disease.

N90-28332# Army Aeromedical Research Lab., Fort Rucker, AL. Sensory Research Div.

# HUMAN FACTORS AND SAFETY CONSIDERATIONS OF NIGHT VISION SYSTEMS FLIGHT

ROBERT W. VERONA (Army Night Vision Lab., Fort Belvoir, VA.) and CLARENCE E. RASH Jul. 1989 23 p Presented at SPIE Technical Symposium on Optics, Electro-Optics and Sensors, Orlando, FL, 27-31 Mar. 1989

(Contract DA PROJ. 3E1-62787-A-879)

(USAARL-89-12) Avail: NTIS HC A03/MF A01

Military aviation night vision systems greatly enhance the capability to operate during periods of low illumination. After flying with night vision devices, most aviators are apprehensive about returning to unaided night flight. Current night vision imaging devices allow aviators to fly during ambient light conditions which would be extremely dangerous, if not impossible, with unaided vision. However, the visual input afforded with these devices does not approach that experienced using the unencumbered, unaided eye during periods of daylight illumination. Many visual parameters, e.g., acuity, field-of-view, depth perception, etc., are compromised when night vision devices are used. The inherent characteristics of image intensification based sensors introduce new problems associated with the interpretation of visual information based on different spatial and spectral content from that of unaided vision. In addition, the mounting of these devices onto the helmet is accompanied by concerns of fatigue resulting from increased head supported weight and shift in center-of-gravity. All of these concerns have produced numerous human factors, and safety issues relating to the use of night vision systems. These issues are identified and discussed in terms of their possible effects on user performance and safety. Author

**N90-28333\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

GENERATION RATES AND CHEMICAL COMPOSITIONS OF WASTE STREAMS IN A TYPICAL CREWED SPACE HABITAT THEODORE WYDEVEN and MORTON A. GOLUB Aug. 1990 27 p Submitted for publication

(NASA-TM-102799; A-90099; NAS 1.15:102799) Avail: NTIS HC A03/MF A01 CSCL 06/11

A judicious compilation of generation rates and chemical compositions of potential waste feed streams in a typical crewed space habitat was made in connection with the waste-management aspect of NASA's Physical/Chemical Closed-Loop Life Support Program. Waste composition definitions are needed for the design of waste-processing technologies involved in closing major life support functions in future long-duration human space missions. Tables of data for the constituents and chemical formulas of the following waste streams are presented and discussed: human urine, feces, hygiene (laundry and shower) water, cleansing agents, trash, humidity condensate, dried sweat, and trace contaminants. Tables of data on dust generation and pH values of the different waste streams are also presented and discussed.

N90-28334# Universitaet der Bundeswehr Muenchen, Neubiberg (Germany, F.R.). Inst. fuer Systemdynamic und Flugmechanik. SCOPE AND CONCEPTION OF THE PILOT SUPPORT SYSTEM ASPIO [AUFGABENSTELLUNG UND KONZEPTION DES PILOTENUNTERSTUETZUNGSSYSTEMS ASPIO] HEINZ-LEO DUDEK Aug. 1988 61 p In GERMAN (LRT-WE-13-FB-88-1; ETN-90-97333) Avail: NTIS HC A04/MF A01

The fundamentals of a system for the relief of pilots were developed. The scope of instrument flying is outlined and the tasks of a pilot support system are described. The concept of the system ASPIO (Assistant for Single-Pilot Instrument flight rules Operation) is presented. Besides the fulfilment of the requirements, a favorable arrangement of the interface was aimed at between pilot and support system. The simulation system for the evaluation of the pilot support system is described. ESA

N90-28335# Centre d'Essais en Vol, Bretigny-sur-Orge (France). Lab. de Medecine Aerospatiale.

TOXICOLOGICAL ASPECTS OF FIRE ONBOARD AIRCRAFTS: ROLE OF THE PRESSURIZATION AND VENTILATION IN THE COCKPIT (ASPECTS TOXICOLOGIQUES DES INCENDIES A BORD DES AERONEFS. ROLE DE LA PRESSURISATION ET DE LA VENTILATION DE LA CABINE, COMPTE RENDU D'ETUDE]

P. C. M. KERGUELEN, M. MIGNET, J. P. BEZARD, J. P. DELANNOY, J. DURAND, and E. VALS Jan. 1990 139 p In FRENCH

(Contract DRET-87-1033)

(ETN-90-97452) Avail: NTIS HC A07/MF A01

The characteristics involving ventilation and pressurization onboard aircrafts during flight are investigated. This work is part of the research program carried out on the thermolysis of materials used in cockpits. Both physicochemical and toxicological aspects of thermolysis and the harmful effects on a mouse were investigated. The results show that the risks of fire are reduced if ventilation increases. Moreover the toxicity increases if the pressure decreases. ESA

**N90-28336** Institute for Perception RVO-TNO, Soesterberg (Netherlands). Thermal Physiology Group.

PHYSICAL CHARACTERISTICS OF CLOTHING MATERIALS WITH REGARD TO HEAT TRANSPORT W. A. LOTENS Mar. 1989 30 p

(Contract B87-63)

(IZF-1989-10; TD-89-1644; ETN-90-97385) Copyright Avail: Institute for Perception RVO-TNO, P.O. Box 23, 3769 ZG Soesterberg, Netherlands

Relevant clothing characteristics for heat transport are insulation, water vapor resistance and mosture absorption. These characteristics, their underlying mechanisms and their measurement are reviewed, in order to make a choice for the best physical description and the most feasible method for its measurement. Clothing insulation depends largely on the insulation of the still air layer that the clothing creates, and the way the insulation is modified by radiation inside the fabric, depending on density and fiber diameter. Clothing insulation can best be measured by a flat plate apparatus with a heat flow meter. Vapor resistance is also dependent on the thickness of the created air

layer, but the fibers hamper the transport according to their volume fraction. The easiest way to express vapor resistance is the thickness of an equivalent air layer. The use of the permeability index im is shown to be ambiguous and the measurement of im full of traps. For the measurement of the air equivalent the DREO diffusion meter is a fast, simple and accurate instrument. The absorption characteristics of various fibers are similar, but the magnitude differs. It is sufficient to describe materials by the single parameter regain. Its measurement is relatively uncomplicated.

ESA

Institute for Perception RVO-TNO, Soesterberg N90-28337 (Netherlands). Traffic Behavior Group.

# CATEGORIZATION AND IDENTIFICATION OF SIMULTANEOUS TARGETS

J. THEEUWES 19 Jul. 1989 17 p

(Contract B88-51)

(IZF-1989-22; TD-89-3365; ETN-90-97389) Copyright Avail: Institute for Perception RVO-TNO, P.O. Box 23, 3769 ZG Soesterberg, Netherlands

Several studies have shown that the time to detect whether a single target categorically different from non targets is present or not, is relatively independent of the number of non targets in the display. Invariance of performance with display size is taken as evidence in favor of late selection theories claiming unlimited capacity, spatially parallel processing of all items in the display. As an extension of previous studies, two categorically different targets were presented simultaneously among a variable number of non target. Subjects were shown brief displays of two target letters among either 2, 4, 6 non target digits. Subjects responded same when the two letters were identical and different otherwise. Since the same-different response reflects the combined outcome of the simultaneous targets, late selection theory predicts that the time to match the target letters is independent of the number of non target digits. Alternatively, early selection theory predicts a linear increase of reaction time with display size since the presence of more than one target disrupts parallel pre-attentive processing, leading to a serial search through all items in the display. The results provide evidence for the early selection view since reaction time increased linearly with the number of categorically different non targets. ESA

N90-28338 Institute for Perception RVO-TNO, Soesterberg (Netherlands). Thermal Physiology Group.

# CALCULATION OF CLOTHING INSULATION AND VAPOUR RESISTANCE

W. A. LOTENS and G. HAVENITH 31 Oct. 1989 33 p (Contract B87-63)

(IZF-1989-49; TD-89-4547; ETN-90-97399) Copyright Avail: Institute for Perception RVO-TNO, P.O. Box 3, 3769 ZG Soesterberg, Netherlands

Based on a physical model, in which a human is depicted as a collection of appropriately sized cylinders, clothing insulation and vapor resistance are calculated for standing persons in still air, when the clothing ensemble thickness, total fabric thickness, number of clothing layers, and number of trapped air layers are specified for each cylinder. Specific knowledge of the clothing material is not required, except when coatings of films are involved. The resulting reference values for clothing insulation and vapor resistance are accurate to a standard deviation of 0.011 sg m K/W and 1.8 mm of air equivalent, respectively, compared to thermal manikin measurement. The reference values are modified for sitting, walking, and cycling at various rates, and for the combined effect with wind. The formulas are regression equations on a data base of literature. The resulting total insulation and vapor resistance are accurate to 0.022 sq m K/W and 3.6 mm of air equivalent, respectively. The physical model, which is available as software, is a challenge to existing methods for the determination of insulation and vapor resistance with respect to simpleness and accuracy. ESA

# 55

# SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

## A90-48092

## ABIOTIC SYNTHESIS OF AMINO ACIDS AND IMIDAZOLE BY PROTON IRRADIATION OF SIMULATED PRIMITIVE EARTH ATMOSPHERES

KENSEI KOBAYASHI, MASAHIKO TSUCHIYA (Yokohama National University, Japan), TAIRO OSHIMA (Tokyo Institute of Technology, Yokohama, Japan), and HIROSHI YANAGAWA (Mitsubishi Kasei Institute of Life Sciences, Tokyo, Japan) (International Society for the Study of the Origin of Life and Ceskoslovenska Akademie Ved, Meeting, Prague, Czechoslovakia, July 4-11, 1989) Origins of Life and Evolution of the Biosphere (ISSN 0169-6149), vol. 20, no. 2, 1990, p. 99-109. refs

Copyright

Proton irradiation of simulated primitive earth atmosphere was performed, and amino acids and imidazole were analyzed. A mixture of carbon monoxide and nitrogen over water was irradiated by high energy protons (3 MeV, 0.6 microA) generated by a Van de Graaff accelerator for 2-5 h. Various kinds of proteinous and nonproteinous amino acids were detected in the irradiation products. Imidazole present in the irradiation products was also detected by high-performance liquid chromatography and mass spectrometry. The present results suggest that compounds of biological importance such as amino acids could be synthesized from primitive earth atmosphere by radiation of cosmic rays and/or solar flare particles. Author

#### A90-48093

SELECTIVE DECOMPOSITION OF EITHER ENANTIOMER OR ASPARTIC ACID IRRADIATED WITH CO-60 GAMMA RAYS IN THE MIXED AQUEOUS SOLUTION WITH D- OR L-ALANINE MITSUHIKO AKABOSHI, KENICHI KAWAI, HIROTOSHI MAKI (Kyoto University, Osaka, Japan), WILHELM EHRLICH (Kyoto University, Osaka, Japan; Bundesgesundheitsamt, Robert Koch Institut, Berlin, Federal Republic of Germany), and YASUHIRO HONDA (Kyoto University, Osaka, Japan; Maryland, University, College Park) (International Society for the Study of the Origin of Life and Ceskoslovenska Akademie Ved, Meeting, Prague, Czechoslovakia, July 4-11, 1989) Origins of Life and Evolution of the Biosphere (ISSN 0169-6149), vol. 20, no. 2, 1990, p. 111-119. Research supported by the University of Tsukuba. refs Copyright

Amino-acid interactions are investigated experimentally, using HPLC with fluorescence detection to analyze the products of selective decomposition of aqueous solutions of glycine, alanine, glycine-alanine, and alanine-aspartic acid exposed to 24-kGy/h of Co-60 gamma rays. The results are presented graphically and discussed in detail. It is found that alanine (but not glycine) acts to protect aspartic acid from the effects of radiation, with selective protection of L-aspartic acid when L-alanine was mixed with D,L aspartic acid. The potential implications of this finding for the selection, amplification, and establishment of chirality in T.K. biomolecules in the primordial earth are indicated.

#### A90-48094

## POSSIBLE AMPLIFICATION OF ENANTIOMER EXCESSES THROUGH STRUCTURAL PROPERTIES OF LIQUID **CRYSTALS - A MODEL FOR ORIGIN OF OPTICAL ACTIVITY** IN THE BIOSPHERE?

W. THIEMANN and H. TEUTSCH (Bremen, Universitaet, Federal Republic of Germany) (International Society for the Study of the Origin of Life and Ceskoslovenska Akademie Ved, Meeting, Prague, Czechoslovakia, July 4-11, 1989) Origins of Life and Evolution of the Biosphere (ISSN 0169-6149), vol. 20, no. 2, 1990, p. 121-126. refs

Copyright

Within the mesophase resulting from a mixture of the tenside Tween 80 and water, a photoinduced isomerization of potassium trioxalato chromate can lead to enantiomer excess. The helical hyperstructure of Tween/water phase is responsible for this effect, which is highly susceptible to external influences. Based on these results, a model is developed which may help to explain the amplification of small enantiomer excesses on the prebiotic earth. Author

#### A90-48095

# **ORIGINS OF LIFE - AN OPERATIONAL DEFINITION**

GAIL RANEY FLEISCHAKER (Harvard University, Cambridge, MA) (International Society for the Study of the Origin of Life and Ceskoslovenska Akademie Ved, Meeting, Prague, Czechoslovakia, July 4-11, 1989) Origins of Life and Evolution of the Biosphere (ISSN 0169-6149), vol. 20, no. 2, 1990, p. 127-137. refs (Contract NSF DIR-89-03206)

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An operational definition of the living makes explicit the system logic of metabolic self-production: (1) that whatever form it may take, life is a function of its biochemical processes; (2) that no single biochemical process has integrity apart from an entire network of processes; (3) that a network of processes can have continuity only by being enclosed within a boundary structure; and (4) that life is a single phenomenon driving the processes that produce its material constituents. This paper presents autopoiesis as life-defining and discusses the utility of its criteria in the search for the origins of life on earth. Enactment of the autopoietic criteria would result in a minimal cell and would demonstrate the experimental recapitulation of life's Archaean origins.

## A90-48096

# CHEMICAL ACTIVITY OF SIMPLE BASIC PEPTIDES

ANDRE BRACK and BERNARD BARBIER (CNRS, Centre de Biophysique Moleculaire, Orleans, France) (International Society for the Study of the Origin of Life and Ceskoslovenska Akademie Ved, Meeting, Prague, Czechoslovakia, July 4-11, 1989) Origins of Life and Evolution of the Biosphere (ISSN 0169-6149), vol. 20, no. 2, 1990, p. 139-144. refs

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Alternating all-L poly(leucyl-lysyl) increases markedly the rate of hydrolysis of oligoribonucleotides. Pure D poly(leucyl-lysyl) is as active as the all-L polymer. The homochiral polypeptides adopt a beta-sheet structure when complexed to the oligonucleotides. Alternating poly(D.L-Leu-D.L-Lys) made of racemic amino acids is much less efficient and is unable to adopt a beta-sheet structure. A set of alternating poly(leucyl-lysyl) ranging from the racemic to the homochiral all-L polymer has been checked. Their the conformations can be described as a mixture of random-coil and beta-sheet conformations, the amount of beta-sheet increasing with the optical purity of the polymer. The hydrolytic activity follows the proportion of beta-sheets, suggesting that the chemical activity is related to the geometry of the chain. Short peptides were prepared in order to evaluate the critical chain length required for the hydrolytic activity. A decapeptide is long enough to present 90 percent of the activity of the corresponding polypeptide.

Author

## A90-48097\* Salk Inst. for Biological Studies, San Diego, CA. ENERGY-RICH GLYCERIC ACID OXYGEN ESTERS -IMPLICATIONS FOR THE ORIGIN OF GLYCOLYSIS

ARTHUR L. WEBER (Salk Institute for Biological Studies, San Diego, CA) and VICTOR HSU (California, University, La Jolla) (International Society for the Study of the Origin of Life and Ceskoslovenska Akademie Ved, Meeting, Prague, Czechoslovakia, July 4-11, 1989) Origins of Life and Evolution of the Biosphere (ISSN 0169-6149), vol. 20, no. 2, 1990, p. 145-150. Research supported by NSF. refs

(Contract NSG-7627; NIH-1-SO1-RR-033420-1) Copyright

The apparent Gibbs free energy change (GFEC) of hydrolysis (pH 7) of the 2- and 3-O-glyceroyl esters of 2- and 3-O-L-glyceroyl-L-glyceric acid methyl ester were measured at 25

C. The 2- and 3-glyceroyl esters were found to be 'energy-rich' with GFEC values of -9.1 kcal/mol and -7.8 kcal/mol, respectively. This result indicates that the analogous 2- and 3-glyceroyl esters of polyglyceric acid are also energy-rich and, therefore, could have acted as an energy source for primitive phosphoanhydride synthesis. Author

# A90-48098\* Salk Inst. for Biological Studies, San Diego, CA. TEMPLATE-DIRECTED OLIGOMERIZATION OF

5-PRIME-DEOXY 5-NUCLEOSIDEACETIC ACID DERIVATIVES KAZUO HARADA and LESLIE E. ORGEL (Salk Institute for Biological Studies, San Diego, CA) (International Society for the Study of the Origin of Life and Ceskoslovenska Akademie Ved, Meeting, Prague, Czechoslovakia, July 4-11, 1989) Origins of Life and Evolution of the Biosphere (ISSN 0169-6149), vol. 20, no. 2, 1990, p. 151-160. refs (Contract NAGW-1660)

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5-prime-deoxy 5-nucleosideacetic acids H-II are isostructural analogs of nucleotides with a carboxylate group in the place of the 5-prime-phosphate group. In this work, their oligomerization in aqueous solution was studied using a water-soluble carbodiimide as the condensing agent in the presence or absence of an appropriate polynucleotide template. Condensation of adenylic acid analogs IIa, IIIa, and Va in the presence of polyuridylic acid were found to be the most efficient reactions. Cyclization of the activated monomers to lactones and the insolubility of the oligomers in aqueous solution were found to be obstacles to the efficient formation of long oligomers. Author

#### A90-48099

# THE CASE FOR THE CHEMOAUTOTROPHIC ORIGIN OF LIFE IN AN IRON-SULFUR WORLD

GUENTER WAECHTERSHAEUSER Origins of Life and Evolution of the Biosphere (ISSN 0169-6149), vol. 20, no. 2, 1990, p. 173-176. refs

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The possibility that the first microorganisms on earth may have been chemoautotrophic (i.e., capable of synthesizing their own carbon compounds from CO2 or other C1 units) rather than heterotrophic (requiring an external source of C compounds) is considered theoretically. Particular attention is given to the energy source for the chemoautotrophic process, which must provide reducing power, a high redox potential, somewhat inhibited electron flow, linear electron flow from the reducing agent to CO2; operate within the organism; and be geochemically plausible. It is suggested that all of these requirements are fulfilled by the oxidative formation of pyrite: FeS + H2S yields FeS2 + 2H(+) + 2e(-). The implications of such a model are briefly explored. T.K.

**A90-48101\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

# IMPACT CONSTRAINTS ON THE ENVIRONMENT FOR CHEMICAL EVOLUTION AND THE CONTINUITY OF LIFE VERNE R. OBERBECK and GUY FOGLEMAN (NASA, Ames

VERNE R. OBERBECK and GUY FOGLEMAN (NASA, Ames Research Center, Moffett Field, CA) (International Society for the Study of the Origin of Life and Ceskoslovenska Akademie Ved, Meeting, Prague, Czechoslovakia, July 4-11, 1989) Origins of Life and Evolution of the Biosphere (ISSN 0169-6149), vol. 20, no. 2, 1990, p. 181-195. refs

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The moon and the earth were bombarded heavily by planetesimals and asteroids that were capable of interfering with chemical evolution and the origin of life. This paper explores the frequency of giant terrestrial impacts able to stop prebiotic chemistry in the probable regions of chemical evolution. The limited time available between impacts disruptive to prebiotic chemistry at the time of the oldest evidence of life suggests the need for a rapid process for chemical evolution of life. On the other hand, rapid chemical evolution in cloud systems and lakes or other shallow evaporating water bodies would have been possible because reactants could have been concentrated and polymerized rapidly in this environment. Thus life probably could have originated

# 55 SPACE BIOLOGY

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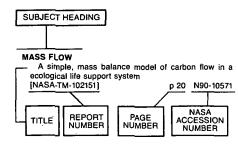
near the surface between frequent surface-sterilizing impacts. There may not have been continuity of life depending on sunlight because there is evidence that life, existing as early as 3.8 Gyr ago, may have been destroyed by giant impacts. The first such organisms on earth were probably not the ancestors of present life. Author

# SUBJECT INDEX

# AEROSPACE MEDICINE AND BIOLOGY / A Continuing Bibliography (Supplement 343)

December 1990

# Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title is used to provide a description of the subject matter. When the title is insufficiently descriptive of document content, a title extension is added, separated from the title by three hyphens. The (NASA or AIAA) accession number and the page number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document. Under any one subject heading, the accession numbers are arranged in sequence with the AIAA accession numbers appearing first.

ABILITIES

The integration of complex information from auditory and visual channels under stress

- [AD-A222686] p 314 N90-27245 ABIOGENESIS
- Report on the workshop 'Chemical evolution and neo-abiogenesis in marine hydrothermal systems p 305 A90-48091
- Abiotic synthesis of amino acids and imidazole by proton irradiation of simulated primitive earth atmospheres
- p 338 A90-48092 Possible amplification of enantiomer excesses through structural properties of liquid crystals - A model for origin of optical activity in the biosphere? p 338 A90-48094
- Origins of life An operational definition p 339 A90-48095 The case for the chemoautotrophic origin of life in an
- iron-sulfur world p 339 A90-48099 ACCELERATION STRESSES (PHYSIOLOGY)
- A case of left hypoglossal neurapraxia following G p 311 A90-48590 exposure in a centrifuge Partial supination versus Gz protection
- p 311 A90-48592 Influence of gravito-inertial force on vestibular nystagmus in man
- p 316 N90-28325 [IZF-1989-241 ACCELERATION TOLERANCE
- Positive pressure breathing for acceleration protection and its role in prevention of inflight G-induced loss of p 311 A90-48591 consciousness
- Partial supination versus Gz protection p 311 A90-48592 Reach performance while wearing the Space Shuttle
- launch and entry suit during exposure to launch accelerations [SAE PAPER 901357] p 330 A90-49390

# ACID BASE EQUILIBRIUM

- The effect of hyperthermia on the cardiovascular system and acid-base composition of blood in dogs p 305 A90-46523
- ACTIVE CONTROL
  - Active thermal control systems for lunar and Martian exploration
  - p 324 A90-49313 [SAE PAPER 901243] Computer aided system engineering and analysis (CASE/A) modeling package for ECLS systems - An verview
- [SAE PAPER 901267] p 327 A90-49336 AČTIVITY (BIOLOGY)
- Stress-induced deficits of the human immune system p 310 A90-48331
- ADAPTATION Adaptation of trained and untrained humans to natural and technogenic extreme factors under the effect of p 310 A90-46522 adaptogens
- ADAPTIVE CONTROL Model-based iterative learning control of Space-Shuttle
- manipulator [AIAA PAPER 90-3398] p 320 A90-47653
- ADENOSINES Chemical structure of a prebiotic analog of adenosine
- p 305 A90-46654 ADRENAL METABOLISM
- Participation of cerebral noradrenergic structures in thermoregulation during the adaptation to cold p 306 A90-48199
- AERONAUTICAL ENGINEERING The integration of complex information from auditory and visual channels under stress
- [AD-A222686] p 314 N90-27245 AEROSPACE ENVIRONMENTS
- Critical technologies Spacecraft habitability [SAE PAPER 901384] p 331 A90-49412 Space Station Freedom contamination requirements and predictions
- p 332 A90-49418 [SAE PAPER 901408] AEROSPACE MEDICINE
- Space Station Freedom CHeCS overview --- Crew Health Care System
- p 312 A90-49327 [SAE PAPER 901258] Space Station requirements for in-flight exercise countermeasures
- p 312 A90-49328 [SAE PAPER 901259] Microbiology facilities aboard Space Station Freedom (SSF)
- [SAE PAPER 901262] p 308 A90-49330 Clinical laboratory diagnosis for space medicine p 312 A90-49331 [SAE PAPER 901263]
- Design and evaluation of an electronic stethoscope system for the Space Station Freedom HMF
- p 313 A90-49363 (SAE PAPER 901323) Space Station Freedom viewed as a 'tight building p 331 A90-49410 [SAE PAPER 901382]
- European Space Station health care system concept p 332 A90-49415 [SAE PAPER 901387] Aerospace medicine and biology: A continuing
- bibliography with indexes (supplement 339) p 316 N90-28327 [NASA-SP-7011(339)] AEROSPACE SAFETY
- Life support Thoughts on the design of safety systems [SAE PAPER 901248] p 325 A90-49318
- AIR COOLING
- Integrated air/water cooling concepts for space laboratory modules p 330 A90-49400 [SAE PAPER 901370]
- AIR DEFENSE Visual mechanisms and predictors of far field visual task
- performance p 311 A90-48700 AIR PURIFICATION
- Engineering testbed for biological water/air reclamation and recycling [SAE PAPER 901231] p 324 A90-49302
- Advanced air revitalization system modeling and testing [SAE PAPER 901332] p 328 A90-49370

associated with bioregenerative	ntamination problems e air/water purification
systems [SAE PAPER 901379]	p 330 A90-49407
AIR QUALITY	
Assessment of internal con associated with bioregenerative a systems	
[SAE PAPER 901379]	p 330 A90-49407
AIR TRAFFIC CONTROL	
Human factors in the computer-generated information - application in automated flight traff	Aspects of design and fic
AIRCRAFT CONSTRUCTION MATE	
Toxicological aspects of fire ont the pressurization and ventilation in	
[ETN-90-97452]	p 337 N90-28335
AIRCRAFT CONTROL Scope and conception of the	e pilot support system
ASPIO [LRT-WE-13-FB-88-1]	p 337 N90-28334
AIRCRAFT INSTRUMENTS	· · ·
<ul> <li>Scope and conception of the ASPIO</li> </ul>	pilot support system
[LRT-WE-13-FB-88-1]	p 337 N90-28334
AIRCRAFT PILOTS	
Influence of gravito-inertial nystagmus in man	force on vestibular
[IZF-1989-24]	p 316 N90-28325
Human factors and safety consid	lerations of night vision
systems flight [USAARL-89-12]	p 337 N90-28332
AIRCRAFT SAFETY	•
Scope and conception of the ASPIO	e pilot support system
[LRT-WE-13-FB-88-1]	p 337 N90-28334
ALANINE Selective decomposition of either	enantiomer or aspartic
acid irradiated with Co-60 gamm aqueous solution with D- or L-alan	
ALTITUDE SICKNESS	p 336 A90-46093
Altitude decompression sickness results in 528 cases	s - Hyperbaric therapy p 311 A90-48589
AMINO ACIDS	
Abiotic synthesis of amino acids a irradiation of simulated primitive ea	
	p 338 A90-48092
ANIMALS Bioelectromagnetic effects of the	Electromagnetic Pulse
(EMP) [AD-A221552]	p 309 N90-27243
ANTHROPOMETRY	·
Hermes-crew integration aspects [SAE PAPER 901390]	s p 332 A90-49417
The relationship of isometric	
dynamometer settings, and co	
factors [AD-A222046]	p 334 N90-27264
Physiological reactions to heat	stress; quantifying the
effects of individual parameters [IZF-1989-30]	p 316 N90-28326
ANTIBODIES Anti-LPS antibodies reduce endo	ntovemia in whole body
Co-60 irradiated primates - A prelir	minary report
Pseudomonas diagnostic assay	p 306 A90-48584
[NASA-CASE-NPO-17653-1-CU] ANTIRADIATION DRUGS	p 308 N90-27239
Anti-LPS antibodies reduce endo Co-60 irradiated primates - A prelir	
ANTISEPTICS	p 306 A90-48584
Application of the pentaiodid	
disinfectant to the U.S. space prog	
[SAE PAPER 901380]	
APTITUDE	p 331 A90-49408
	p 331 A90-49408

# AQUEOUS SOLUTIONS

# AQUEOUS SOLUTIONS

Radiation-induced polymerization in dilute aqueous solutions of cvanides p 305 A90-46655 Selective decomposition of either enantiomer or aspartic acid irradiated with Co-60 gamma rays in the mixed aqueous solution with D- or L-alanine n 338 A90-48093

ARCHITECTURE (COMPUTERS) Symbolic architectures for cognition

n 318 N90-27254 IAD-A2229091 A study on diagnosability of space station ECLSS p 335 N90-27294

Creature co-op: Achieving robust remote operations with a community of low-cost robots p 336 N90-27303 ARM (ANATOMY)

Criteria for a recommended standard: Occupational exposure to hand-arm vibration [PB90-168048] p 337 N90-28331

ARTIFICIAL INTELLIGENCE Symbolic architectures for cognition

- p 318 N90-27254 [AD-A222909] Agent independent task planning p 335 N90-27276 Space Station Freedom ECLSS: A step toward Agent independent task planning autonomous regenerative life support systems p 335 N90-27297
- Simulation-based intelligent robotic agent for Space p 335 N90-27298 Station Freedom ASPARTIC ACID

Selective decomposition of either enantiomer or aspartic acid irradiated with Co-60 gamma rays in the mixed aqueous solution with D- or L-alanine p 338 A90-48093

ASSAYING

Pseudomonas diagnostic assav

- [NASA-CASE-NPO-17653-1-CU] p 308 N90-27239 ASTRONAUT MANEUVERING EQUIPMENT
- Emulation of the Eva Soviet suit for neutral buoyancy simulations
- SAE PAPER 901246 p 324 A90-49316 ASTRONAUT PERFORMANCE
- Human exercise capabilities in space [SAE PAPER 901200]
- p 312 A90-49276 Astronaut exposure to space radiation - Space Shuttle [SAE PAPER 901342] p 313 A90-49377
- Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations
- ISAE PAPER 9013571 p 330 A90-49390 ASTRONAUT TRAINING
- Emulation of the Eva Soviet suit for neutral buoyancy simulations [SAE PAPER 901246] p 324 A90-49316
- **ASTRONAUTS**
- A direct-interface fusible heat sink for astronaut cooling [SAE PAPER 901433]
- p 333 A90-49434 ATMOSPHERIC CHEMISTRY
- Abiotic synthesis of amino acids and imidazole by proton irradiation of simulated primitive earth atmospheres p 338 A90-48092

#### ATMOSPHERIC COMPOSITION

- Atmosphere Composition Monitor for predevelopment operational system test p 326 A90-49325
- ISAE PAPER 9012561 Identifying atmospheric monitoring needs for Space Station Freedom
- [SAE PAPER 901383] p 331 A90-49411 ATTENTION
- Conference on The Perception of Structure Program and Abstracts p 319 N90-28328 1AD-A2224371
- AUDITORY PERCEPTION Binaural masking: An analysis of models
- [AD-A221668] p 315 N90-27252 AUDITORY SIGNALS
- Binaural masking: An analysis of models p 315 N90-27252 [AD-A221668] AUDITORY STIMULI
- Binaural masking: An analysis of models [AD-A221668]
- p 315 N90-27252 AUTOMATIC FLIGHT CONTROL Human factors in the presentation
- computer-generated information Aspects of design and application in automated flight traffic p 321 A90-49270
- AUTOMATIC PILOTS

A-2

- Scope and conception of the pilot support system ASPIO [LRT-WE-13-FB-88-1] p 337 N90-28334
- AUTONOMY
- Space Station Freedom ECLSS: A step toward autonomous regenerative life support systems p 335 N90-27297

AXES OF BOTATION

Nystagmus responses in a group of normal humans during earth-horizontal axis rotation p 317 A90-49046

## В

#### BACTERIA

- Different effects of eubacterial and eukaryotic DNA topoisomerase II inhibitors on chloroplasts of Euglena p 306 A90-48100 aracilis BEARING (DIRECTION)
- Tracking a head-mounted display in a room-sized environment with head-mounted cameras [AD-A222545] p 335 N90-27266
- BEHAVIOR Effects of competition on video-task performance in
- monkeys (Macaca mulatta) p 317 A90-49039 BIBLIOGRAPHIES Aerospace medicine and biology: A continuing
- bibliography with indexes (supplement 339) p 316 N90-28327 [NASA-SP-7011(339)] BINALIBAL HEARING
- Binaural masking: An analysis of models AD-A2216681 p 315 N90-27252
- BIOASTRONAUTICS
- Effects of acute hypoxia on cardiopulmonary responses p 310 A90-48583 to head-down tilt Development of the Space Station Freedom Environmental Health System
- SAE PAPER 901260 p 312 A90-49329 Microbiology facilities aboard Space Station Freedom (SSE)
- SAE PAPER 9012621 p 308 A90-49330 European Space Station health care system concept [SAE PAPER 901387] p 332 A90-49415
- Aerospace medicine and biology: A continuing bibliography with indexes (supplement 339)
- [NASA-SP-7011(339)] p 316 N90-28327 BIOCHEMISTRY
- The effect of hyperthermia on the cardiovascular system and acid-base composition of blood in dogs
- p 305 A90-46523 The chronic effect of an electrostatic field on certain biochemical indices of tissues p 305 A90-46524 Energy-rich glyceric acid oxygen esters - Implications for the origin of glycolysis p 339 A90-48097
- BIODYNAMICS
- Hermes-crew integration aspects
- [SAE PAPER 901390] p 332 A90-49417 **BIOLOGICAL EFFECTS**
- Nuclear reaction effects in conventional risk assessment for energetic ion exposure p 311 A90-49065 Risk assessment methodologies for target fragments
- produced in high-energy nucleon reactions p 312 A90-49066
- Neurobehavioral effects of carbon monoxide (CO) exposure in humans: Elevated carboxyhemoglobin (COHb) and cerebrovascular responses
- [AD-A222840] p 314 N90-27246 Aerospace medicine and biology: A continuing pibliography with indexes (supplement 339)
- p 316 N90-28327 [NASA-SP-7011(339)] Criteria for a recommended standard: Occupational
- exposure to hand-arm vibration p 337 N90-28331 (PB90-168048) **BIOLOGICAL EVOLUTION**
- Origins of life An operational definition
- p 339 A90-48095 Different effects of eubacterial and eukaryotic DNA topoisomerase II inhibitors on chloroplasts of Euglena p 306 A90-48100
- gracilis Impact constraints on the environment for chemical evolution and the continuity of life p 339 A90-48101 BIOLOGICAL MODELS (MATHEMATICS)
- Internal representation, internal model, human performance model and mental workload
- p 317 A90-47500 Changes in geometrical and biomechanical properties
- of immature male and female rat tibia p 306 A90-48587
- BIOMEDICAL DATA
- Medical information BUS Integrated monitoring for the HMF of Space Station Freedom [SAE PAPER 901328] p 313 A90-49367
- BIONICS Effects of protracted ionizing radiation dosage on
- humans and animals: A brief review of selected investigations [AD-A222240] p 309 N90-27241
- BIOSATELLITES Plant biology research on 'LifeSat' [SAE PAPER 901227]
- p 307 A90-49299 Facilities for animal research in space with special reference to Space Station Freedom [SAE PAPER 901303] p 308 A90-49355

# BIOSYNTHESIS

- Origins of life An operational definition
- p 339 A90-48095 BLOOD

SUBJECT INDEX

- Neurobehavioral effects of carbon monoxide (CO) exposure in humans: Elevated carboxyhemoglobin (COHb) and cerebrovascular responses
- [AD-A222840] p 314 N90-27246 **BLOOD CIRCULATION**
- The effect of hyperthermia on the cardiovascular system and acid-base composition of blood in dogs
- p 305 A90-46523 BODY MEASUREMENT (BIOLOGY)
- Changes in geometrical and biomechanical properties of immature male and female rat tibia
- p 306 A90-48587
- BODY TEMPERATURE

CABIN ATMOSPHERES

(SAE PAPER 901265)

(SAF PAPER 901268)

[SAE PAPER 901383]

ionizing radiation [SAE PAPER 901344]

AIAA PAPER 90-3432]

control systems

Station Freedom

(AD-A2225451

CAPTURE EFFECT

CARBOHYDRATES

[AD-A222877]

CARBON DIOXIDE

control systems [SAE PAPER 901268]

CARBON COMPOUNDS

SAE PAPER 901354

Station ECLSS testing

ISAE PAPER 901252

and further activities [SAE PAPER 901289]

testing [SAE PAPER 901332]

and cerebrovascular responses

CARBON MONOXIDE

(AD-A222840)

CARBON DIOXIDE REMOVAL

New total organic carbon analyzer

CAMERAS

CANCER

robot

loading

The influence of serotonine and histamine, introduced in small doses, on body temperature n 306 A90-48200

	p 000	,	10200
Physical characteristics of clothing	materials	with	regard
to heat transport			
1175 1000 101	- 007		00000

- [IZF-1989-10] p 337 N90-28336 BRAIN
- The chronic effect of an electrostatic field on certain biochemical indices of tissues p 305 A90-46524 The integrated area measure of visual endogenous
- ERPs: Relation to cognitive workload and hemisphere [AD-A223191] p 318 N90-27255 BRAIN CIRCULATION
- Neurobehavioral effects of carbon monoxide (CO) exposure in humans: Elevated carboxyhemoglobin (COHb) and cerebrovascular responses
- [AD-A222840] n 314 N90-27246 BROADBAND
  - Accurate determination of the complex permittivity of biological tissue at 90 GHz, 70 GHz, and over a broad band around 35 GHz [AD-A222062]
    - p 309 N90-27240

p 326 A90-49335

p 331 A90-49411

p 320 A90-46400

p 335 N90-27266

p 313 A90-49379

p 321 A90-47685

p 315 N90-27247

p 329 . A90-49387

p 325 A90-49321

p 326 A90-49335

p 327 A90-49349

p 328 A90-49370

p 314 N90-27246

# С

Application of a comprehensive G189A ECLSS model

in assessing specific Space Station conditions [SAE PAPER 901265] p 326 A90-49333

Integrated model of G189A and Aspen-plus for the

Identifying atmospheric monitoring needs for Space

Tracking a head-mounted display in a room-sized

Recent developments in estimates of cancer risk from

Capture control for manipulator arm of free-flying space

Work enhancement and thermal changes during

Phase III Simplified Integrated Test (SIT) results - Space

Integrated model of G189A and Aspen-plus for the

ECLS technology development programme - Results

Advanced air revitalization system modeling and

Neurobehavioral effects of carbon monoxide (CO)

exposure in humans: Elevated carboxyhemoglobin (COHb)

transient modeling of extravehicular activity atmospheric

intermittent work in cool water after carbohydrate

Three-dimensional camera space manipulation

environment with head-mounted cameras

transient modeling of extravehicular activity atmospheric

# SUBJECT INDEX

### CARBOXYHEMOGLOBIN

Neurobehavioral effects of carbon monoxide (CO) exposure in humans: Elevated carboxyhemoglobin (COHb) and cerebrovascular responses (AD-A222840) p 314 N90-27246

CARDIOVASCULAR SYSTEM

Use of automated systems for the assessment of the health and the adaptive potentials of humans p 310 A90-46521

The effect of hyperthermia on the cardiovascular system and acid-base composition of blood in dogs

p 305 A90-46523 Effects of acute hypoxia on cardiopulmonary responses to head-down tilt p 310 A90-48583

Computer simulation of cardiovascular changes during extended duration space flights SAE PAPER 901359] p 314 A90-49392

CATECHOLAMINE

A network model of catecholamine effects - Gain, p 317 A90-47247 signal-to-noise ratio, and behavior CELLS (BIOLOGY) Origins of life - An operational definition

p 339 A90-48095 Mechanisms of microwave induced damage in biologic materials

p 309 N90-27242 (AD-A222454) CENTRAL NERVOUS SYSTEM

A network model of catecholamine effects - Gain, p 317 A90-47247 signal-to-noise ratio, and behavior CENTRIFUGING STRESS

A case of left hypoglossal neurapraxia following G exposure in a centrifuge p 311 A90-48590 Scientific uses and technical implementation of a

variable gravity centrifuge on Space Station Freedom [SAE PAPER 901360] p 330 A90-49393 p 330 A90-49393 CEREBRAL CORTEX Participation of cerebral noradrenergic structures in

thermoregulation during the adaptation to cold p 306 A90-48199 CHEMICAL BONDS

Did membrane electrochemistry precede translation? p 305 A90-46652

CHEMICAL COMPOSITION Generation rates and chemical compositions of waste streams in a typical crewed space habitat

p 337 N90-28333 [NASA-TM-102799] CHEMICAL EVOLUTION Radiation-induced polymerization in dilute aqueous

p 305 A90-46655 solutions of cyanides Report on the workshop - 'Chemical evolution and neo-abiogenesis in marine hydrothermal systems

p 305 A90-48091 Selective decomposition of either enantiomer or aspartic acid irradiated with Co-60 gamma rays in the mixed aqueous solution with D- or L-alanine p 338 A90-48093

Possible amplification of enantiomer excesses through structural properties of liquid crystals - A model for origin of optical activity in the biosphere? p 338 A90-48094 Chemical activity of simple basic peptides p 339 A90-48096

The case for the chemoautotrophic origin of life in an p 339 A90-48099 iron-sulfur world Impact constraints on the environment for chemical p 339 A90-48101 evolution and the continuity of life

CHLOROPLASTS Different effects of eubacterial and eukaryotic DNA

topoisomerase II inhibitors on chloroplasts of Euglena p 306 A90-48100 CIRCADIAN RHYTHMS

Melatonin, light and, circadian cycles p 318 N90-27256 [AD-A2231961 The 1989 Gordon Research Conference on Chronobiology

[AD-A221972] p 309 N90-28322 CLAMPS Rotationally actuated prosthetic helping hand

[NASA-CASE-MFS-28426-1] p 334 N90-27261 CLINICAL MEDICINE

Clinical laboratory diagnosis for space medicine [SAE PAPER 901263] p 312 A90-49331

CLOSED ECOLOGICAL SYSTEMS Water recycling system for CELSS environment in

[SAE PAPER 901208] p 322 A90-49283 Quality assessment of plant transpiration water

p 323 A90-49301 [SAE PAPER 901230] Engineering testbed for biological water/air reclamation and recycling

p 324 A90-49302 [SAE PAPER 901231] Biosphere 2 project status - Design of a closed manned terrestrial ecological system

p 324 A90-49303 [SAE PAPER 901233] Facilities for animal research in space with special

reference to Space Station Freedom [SAE PAPER 901303] p 308 A90-49355

Research centrifuge accommodations on Space Station Freedom

[SAE PAPER 901304] p 308 A90-49356 A generalized photosynthetic model for plant growth within a closed artificial environment

p 308 A90-49369 [SAE PAPER 901331] Assessment of internal contamination problems associated with bioregenerative air/water purification systems

[SAE PAPER 901379] p 330 A90-49407 Critical technologies - Spacecraft habitability [SAE PAPER 901384] p 331 p 331 A90-49412

CLOTHING Calculation of clothing insulation and vapour resistance p 338 N90-28338

[JZF-1989-49] COCKPITS

Cockpit Ocular Recording System (CORS) p 314 N90-27244 [NASA-CR-4281] COGNITION

Symbolic architectures for cognition p 318 N90-27254 [AD-A222909]

The integrated area measure of visual endogenous ERPs: Relation to cognitive workload and hemisphere p.318 N90-27255 [AD-A223191] Conference on The Perception of Structure Program and

Abstracts p 319 N90-28328 140.42224371

COLOR VISION The effects of luminance boundaries on color

perception [AD-A221544] p 315 N90-27251

COLUMBUS SPACE STATION

Atmosphere trace gas contamination management for the COLUMBUS pressurized modules [SAE PAPER 901288] p 327 A90-49348

ECLS technology development programme - Results and further activities p 327 A90-49349 [SAE PAPER 901289]

Integrated air/water cooling concepts for space laboratory modules p 330 A90-49400

[SAE PAPER 901370] COMMAND AND CONTROL

Automatic information processing and high performance skills: Application to training [AD-A221709]

p 319 N90-27259 COMPETITION

Effects of competition on video-task performance in monkeys (Macaca mulatta) p 317 A90-49039 COMPUTATION

Curvature estimation in orientation selection p 315 N90-27249 [AD-A221481]

COMPUTER AIDED DESIGN LSOPP II - A program for advanced EVA system modeling and trade studies

[SAE PAPER 901264] p 326 A90-49332

Computer aided system engineering and analysis (CASE/A) modeling package for ECLS systems - An overview

[SAE PAPER 901267] p 327 A90-49336 A prototype computer-aided modelling tool for life-support system models

p 327 A90-49337 [SAE PAPER 901269] COMPUTER ASSISTED INSTRUCTION

Human factors research in aircrew performance and training [AD-A221657] p 335 N90-27267

COMPUTER GRAPHICS

3-D components of a biological neural network visualized in computer generated imagery, II - Macular neural network p 307 A90-49049 organization presentation Human factors in the of

computer-generated information - Aspects of design and application in automated flight traffic p 321 A90-49270

A study on diagnosability of space station ECLSS p 335 N90-27294 COMPUTER NETWORKS

A study on diagnosability of space station ECLSS p 335 N90-27294

COMPUTER PROGRAMMING

A study on diagnosability of space station ECLSS p 335 N90-27294

COMPUTER VISION Three-dimensional camera space manipulation p 320 A90-46400

A vision-based telerobotic control station p 336 N90-27311

COMPUTERIZED SIMULATION

Medical information BUS - Integrated monitoring for the HMF of Space Station Freedom

[SAE PAPER 901328] p 313 A90-49367 Computer simulation of a regenerative life support system for a lunar base

(SAE PAPER 901329) p 328 A90-49368

A generalized photosynthetic model for plant growth within a closed artificial environment

DETECTION

[SAE PAPER 901331] p 308 A90-49369 Computer simulation of cardiovascular changes during xtended duration space flights. [SAE PAPER 901359] p 314 A90-49392 Habitability studies for Hermes - A status of simulation and validation [SAE PAPER 901388] p 332 A90-49416 Simulation-based intelligent robotic agent for Space

Station Freedom p 335 N90-27298 Influence of gravito-inertial force on vestibular nystagmus in man

117F-1989-241 p 316 N90-28325 CONFERENCES

Conference on The Perception of Structure Program and Abstracts [AD-A222437] p 319 N90-28328

CONTAMINANTS

Liquid Chromatography/Mass Spectrometry - A new technique for water recovery system testing p 326 A90-49324 [SAE PAPER 901255]

CONTAMINATION Assessment of internal contamination problems associated with bioregenerative air/water purification systems

[SAE PAPER 901379] p 330 A90-49407 CONTROL SYSTEMS DESIGN

Capture control for manipulator arm of free-flying space robot

AIAA PAPER 90-3432 p 321 A90-47685 Active thermal control systems for lunar and Martian exploration

p 324 A90-49313 SAE PAPER 901243 Space Station Freedom ECLSS: A step toward

autonomous regenerative life support systems p 335 N90-27297

Simulation-based intelligent robotic agent for Space p 335 N90-27298 Station Freedom

A vision-based telerobotic control station p 336 N90-27311 COOLING SYSTEMS

A direct-interface fusible heat sink for astronaut

cooling [SAE PAPER 901433] p 333 A90-49434 COSMIC RAYS

Astronaut exposure to space radiation - Space Shuttle experience

ISAE PAPER 9013421 p 313 A90-49377 CREW PROCEDURES (INFLIGHT)

Space Station Crew Quarters and Personal Hygiene Facility

[SAE PAPER 901301] p 328 A90-49353 CURVATURE

Curvature estimation in orientation selection [AD-A221481] p 315 N90-27249

CYANIDES Radiation-induced polymerization in dilute aqueous solutions of cyanides p 305 A90-46655

The measurement of dark adaptation level in the

Automatic information processing and high performance

Automatic information processing and high performance

Selective decomposition of either enantiomer or aspartic acid irradiated with Co-60 gamma rays in the mixed

Altitude decompression sickness - Hyperbaric therapy

Different effects of eubacterial and eukaryotic DNA

topoisomerase II inhibitors on chloroplasts of Euglena gracilis p 306 A90-48100

Superhelicity and DNA radiation sensitivity

Designing space habitats for human productivity [SAE PAPER 901204] p 322 A90

EVA life support design advancements

Pseudomonas diagnostic assav

[NASA-CASE-NPO-17653-1-CU]

p 316 N90-28323

p 319 N90-27259

p 319 N90-27260

p 338 A90-48093

p 311 A90-48589

p 308 A90-49383

p 322 A90-49279

p 324 A90-49315

p 308 N90-27239

A-3

# D

DARK ADAPTATION presence of glare

PR90-1559871

[AD-A221709]

[AD-A221744]

DECOMPOSITIÓN

DATA PROCESSING

skills: Application to training

DECOMPRESSION SICKNESS

DEOXYRIBONUCLEIC ACID

[SAE PAPER 901349]

SAE PAPER 901245]

DESIGN ANALYSIS

DETECTION

results in 528 cases

skills: Acquisition, transfer, and retention

aqueous solution with D- or L-alanine

#### DIRECTION

A model for a space shuttle safing and failure-detection expert p 336 N90-27314 DIRECTION

- The effects of training on errors of perceived direction in perspective displays
- [NASA-TM-102792] p 319 N90-28329 DISPLAY DEVICES
- Human factors in the presentation of computer-generated information - Aspects of design and application in automated flight traffic
- p 321 A90-49270 Robot dynamics in reduced gravity environment p 336 N90-27333
- The dynamics of orbital maneuvering: Design and evaluation of a visual display aid for human controllers p 336 N90-27767
- The effects of training on errors of perceived direction in perspective displays
- [NASA-TM-102792] p 319 N90-28329 DISTRIBUTED PARAMETER SYSTEMS
- Space Station Freedom ECLSS: A step toward autonomous regenerative life support systems p 335 N90-27297

#### DRUGS

- RU 24969-induced emesis in the cat 5-HT1 sites other than 5-HT1A, 5-HT1B or 5-HT1C implicated p 307 A90-49041
- Melatonin, light and, circadian cycles [AD-A223196] p 318 N90-27256

#### DÚST

- Generation rates and chemical compositions of waste streams in a typical crewed space habitat [NASA-TM-102799] p 337 N90-28333
- [NASA-TM-102799] p 337 N90-28333 DYNAMIC CHARACTERISTICS
- The dynamics of orbital maneuvering: Design and evaluation of a visual display aid for human controllers p 336 N90-27767

#### DYNAMIC CONTROL

- Robot dynamics in reduced gravity environment p 336 N90-27333
- DYNAMOMETERS The relationship of isometric grip strength, optimal dynamometer settings, and certain anthropometric factors
- [AD-A222046] p 334 N90-27264

# E

#### EAR

A-4

- The effects of blast trauma (impulse noise) on hearing: A parametric study source 2
- [AD-A221731] p 316 N90-27253 EARTH ENVIRONMENT
- Impact constraints on the environment for chemical evolution and the continuity of life p 339 A90-48101 EARTH ORBITAL ENVIRONMENTS
- LifeSat Radiation research
- [SAE PAPER 901228]
   p 307
   A90-49300

   Habemsi study A study on human factors for space station design
   [SAE PAPER 901416]
   p 332
   A90-49424
- [SAE PAPER 901416] p 332 A90-49424 EARTH ORBITS
- Research centrifuge accommodations on Space Station Freedom
- [SAE PAPER 901304] p 308 A90-49356 EARTH ROTATION
- Nystagmus responses in a group of normal humans during earth-horizontal axis rotation p 317 A90-49046 Earth horizontal axis rotational responses in patients with unilateral peripheral vestibular deficits
- p 318 A90-49069
- Automatic information processing and high performance skills: Application to training
- [AD-A221709] p 319 N90-27259 Automatic information processing and high performance skills: Acquisition, transfer, and retention
- [AD-A221744] p 319 N90-27260 ELECTRIC FIELDS
- The chronic effect of an electrostatic field on certain biochemical indices of tissues p 305 A90-46524 ELECTROCARDIOGRAPHY
- Electrocardiogram of military aircraft pilots measured during real flight missions: Study of the variability of the cardiac rhythm in correlation with working stress [ETN-90-97453] p 316 N90-28324
- ELECTROCHEMISTRY Did membrane electrochemistry precede translation?
- p 305 A90-46652 ELECTROMAGNETIC FIELDS
- Bioelectromagnetic effects of the Electromagnetic Pulse (EMP)

[AD-A221552]	p 309	N90-27243

- ELECTROMAGNETIC PULSES
- Bioelectromagnetic effects of the Electromagnetic Pulse (EMP)
- [AD-A221552] p 309 N90-27243 ELECTROMAGNETIC RADIATION
- Mechanisms of microwave induced damage in biologic materials
- [AD-A222454] p 309 N90-27242 ELECTRON TRANSFER
- Did membrane electrochemistry precede translation? p 305 A90-46652
- ELECTRONIC EQUIPMENT
- Design and evaluation of an electronic stethoscope system for the Space Station Freedom HMF [SAE PAPER 901323] p 313 A90-49363
- END EFFECTORS
- The kinematics and dynamics of space manipulators -The virtual manipulator approach p 320 · A90-46399 On dynamics and control of multi-link flexible space manipulators
- [AIAA PAPER 90-3396] p 320 A90-47651 A preliminary study on experimental simulation of
- dynamics of space manipulator system [AIAA PAPER 90-3399] p 321 A90-47654
- Smart end effector for dexterous manipulation in space [AIAA PAPER 90-3434] p 321 A90-47687
- ENDOCRINE SYSTEMS
- Hormonal changes after parabolic flight Implications on the development of motion sickness p 311 A90-48588
- ENERGETIC PARTICLES
- Nuclear reaction effects in conventional risk assessment for energetic ion exposure p 311 A90-49065 Risk assessment methodologies for target fragments
- produced in high-energy nucleon reactions p 312 A90-49066
- ENVIRONMENTAL CONTROL
- Japanese research activities of life support system [SAE PAPER 901205] p 322 A90-49280 Status of JEM ECLSS design
- [SAE PAPER 901209] p 322 A90-49284 Past and present environmental control and life support
- systems on manned spacecraft [SAE PAPER 901210] p 323 A90-49285
- Space Station Freedom Environmental Control and Life Support System design - A status report
- [SAE PAPER 901211] p 323 A90-49286 Optimal configuration and operation for the Space
- Shuttle Freedom ECLSS [SAE PAPER 901212] p 323 A90-49287
- Human subjects concerns in ground based ECLSS testing - Managing uncertainty in closely recycled systems
- [SAE PAPER 901251] p 325 A90-49320 Phase III Simplified Integrated Test (SIT) results - Space Station ECLSS testing
- [SAE PAPER 901252] p 325 A90-49321 Facility for generating crew waste water product for ECLSS testing
- [SAE PAPER 901254] p 325 A90-49323 Atmosphere Composition Monitor for predevelopment
- operational system test [SAE PAPER 901256] p 326 A90-49325
- Application of a comprehensive G189A ECLSS model in assessing specific Space Station conditions
- [SAE PAPER 901265] p 326 A90-49333 Integrated model of G189A and Aspen-plus for the transient modeling of extravehicular activity atmospheric control systems
- [SAE PAPER 901268] p 326 A90-49335 Computer aided system engineering and analysis (CASE/A) modeling package for ECLS systems - An
- overview [SAE PAPER 901267] p 327 A90-49336 ECLS technology development programme - Results
- and further activities [SAE PAPER 901289] p 327 A90-49349
- Design definition of the Space Station Freedom Galley and Wardroom subsystems and their effect on Space Station Environmental Systems
- [SAE PAPER 901299] p 327 A90-49351 Development of the Space Station Freedom Refrigerator/Freezer and Freezer
- [SAE PAPER 901300] p 328 A90-49352 Space Station Freedom science support equipment [SAE PAPER 901302] p 328 A90-49354 Computer simulation of a regenerative life support
- system for a lunar base [SAE PAPER 901329] p 328 A90-49368 ENVIRONMENTAL MONITORING
- Identifying atmospheric monitoring needs for Space Station Freedom
- [SAE PAPER 901383] p 331 A90-49411

### ENZYMES

Different effects of eubacterial and eukaryotic DNA topoisomerase II inhibitors on chloroplasts of Euglena gracilis p 306 A90-48100 EPIDEMIOLOGY

SUBJECT INDEX

- Bioelectromagnetic effects of the Electromagnetic Pulse (EMP)
- [AD-A221552] p 309 N90-27243 ESTERS
- Energy-rich glyceric acid oxygen esters Implications for the origin of glycolysis p 339 A90-48097
- ESTIMATES Recent developments in estimates of cancer risk from ionizing radiation
- [SAE PAPER 901344] p 313 A90-49379 ETIOLOGY
- The susceptibility of rhesus monkeys to motion sickness p 306 A90-48585 EUKARYOTES
- Different effects of eubacterial and eukaryotic DNA topoisomerase II inhibitors on chloroplasts of Euglena gracilis p 306 A90-48100

# EUROPEAN SPACE AGENCY

- Water recycling in space [SAE PAPER 901247] p 325 A90-49317 Critical technologies - Spacecraft habitability
- [SAE PAPER 901384] p 331 A90-49412 EUROPEAN SPACE PROGRAMS
- European Space Station health care system concept [SAE PAPER 901387] p 332 A90-49415 EVAPORATION
- Physical characteristics of clothing materials with regard to heat transport
- [IZF-1989-10] p 337 N90-28336 Calculation of clothing insulation and vapour resistance
- [IZF-1989-49] p 338 N90-28338 EVOKED RESPONSE (PSYCHOPHYSIOLOGY)
- Evoked potentials during periods of look fixation and periods of saccadic eye movement in humans p 309 A90-46520 FXFRCISE PHYSIOLOGY

Space Station requirements for in-flight exercise

Work enhancement and thermal changes during

Changes in geometrical and biomechanical properties

Facilities for animal research in space with special

Design and evaluation of an electronic stethoscope

Aerospace medicine and biology: A continuing bibliography with indexes (supplement 339)

A model for a space shuttle safing and failure-detection

Resolution of seven-axis manipulator redundancy: A

The effects of blast trauma (impulse noise) on hearing:

Mechanisms of microwave induced damage in biologic

Deep-space radiation exposure analysis for solar cycle

Development of the suit enclosure of the European EVA

LSOPP II - A program for advanced EVA system

EVA life support design advancements

intermittent work in cool water after carbohydrate

p 312 A90-49276

p 312 A90-49328

p 315 N90-27247

p 306 A90-48587

p 307 A90-49299

p 308 A90-49355

p 313 A90-49363

p 316 N90-28327

p 336 N90-27314

p 336 N90-27331

p 316 N90-27253

p 309 N90-27242

p 307 A90-49300

p 314 A90-49381

p 324 A90-49314

p 324 A90-49315

p 326 A90-49332

Human exercise capabilities in space

of immature male and female rat tibia

Plant biology research on 'LifeSat'

reference to Space Station Freedom

system for the Space Station Freedom HMF

[SAE PAPER 901200]

(SAE PAPER 901259)

[SAE PAPER 901227]

[SAE PAPER 901303]

ISAE PAPER 9013231

[NASA-SP-7011(339)]

A parametric study source 2

EXTRATERRESTRIAL RADIATION

l ifeSat - Radiation research

[SAE PAPER 901228]

[SAE PAPER 901347]

[SAE PAPER 901244]

(SAE PAPER 901245)

[SAE PAPER 901264]

modeling and trade studies

EXTRAVEHICULAR ACTIVITY

EXPERT SYSTEMS

heuristic issue

[AD-A221731]

[AD-A222454]

XXI (1975-1986)

space suit

EXPLOSIONS

EXPOSURE

materials

expert

countermeasures

[AD-A222877]

EXOBIOLOGY

loading

#### SUBJECT INDEX

Integrated model of G189A and Aspen-plus for the transient modeling of extravehicular activity atmospheric control systems [SAE PAPER 901268] p 326 A90-49335

- AX-5 space suit reliability model
- [SAE PAPER 901361] p 330 A90-49394 IVA and EVA work place design for a man-tended system
- [SAE PAPER 901415] p 332 A90-49423 Requirements for extravehicular activities on the lunar
- and Martian surfaces [SAE PAPER 901427] p 333 A90-49428
- Design considerations for future planetary space suits [SAE PAPER 901428] p 333 A90-49429 A methodology for choosing candidate materials for the
- fabrication of planetary space suit structures [SAE PAPER 901429] p 333 A90-49430 An air bearing fan for EVA suit ventilation
- [SAE PAPER 901432] p 333 A90-49433 A direct-interface fusible heat sink for astronaut cooling
- [SAE PAPER 901433] p 333 A90-49434 EXTRAVEHICULAR MOBILITY UNITS
- Emulation of the Eva Soviet suit for neutral buoyancy simulations [SAE PAPER 901246] p 324 A90-49316
- Requirements for extravehicular activities on the lunar and Martian surfaces [SAE PAPER 901427] p 333 A90-49428
- EYE MOVEMENTS
- Eyes open versus eyes closed Effect on human rotational responses p 318 A90-49070

#### .

#### FABRICS

- A methodology for choosing candidate materials for the fabrication of planetary space suit structures [SAE PAPER 901429] p 333 A90-49430
- FAILURE MODES A model for a space shuttle safing and failure-detection expert p 336 N90-27314
- FAN BLADES
- An air bearing fan for EVA suit ventilation
- [SAE PAPER 901432] p 333 A90-49433 FAULT TOLERANCE
- A study on diagnosability of space station ECLSS p 335 N90-27294
- Space Station Freedom ECLSS: A step toward autonomous regenerative life support systems p 335 N90-27297

#### FECES

- Generation rates and chemical compositions of waste streams in a typical crewed space habitat [NASA-TM-102799] p 337 N90-28333
- FEEDBACK CONTROL On dynamics and control of multi-link flexible space
- manipulators [AIAA PAPER 90-3396] p 320 A90-47651
- [AIAA PAPER 90-3396]
   p 320
   A90-47651

   The intrinsic approach to space robotic manipulators
   [AIAA PAPER 90-3431]
   p 321
   A90-47684
- Smart end effector for dexterous manipulation in space [AIAA PAPER 90-3434] p 321 A90-47687
- FINGERS
- Rotationally actuated prosthetic helping hand [NASA-CASE-MFS-28426-1] p 334 N90-27261
- Criteria for a recommended standard: Occupational exposure to hand-arm vibration [PB90-168048] p 337 N90-28331
- FLAMMABILITY Toxicological aspects of fire onboard aircrafts: Role of
- the pressurization and ventilation in the cockpit [ETN-90-97452] p 337 N90-28335 FLEXIBLE SPACECRAFT
- On dynamics and control of multi-link flexible space manipulators
- [AIAA PAPER 90-3396] p 320 A90-47651 Dynamics and positioning control of space robot with flexible manipulators
- [AIAA PAPER 90-3397] p 320 A90-47652 A preliminary study on experimental simulation of
- dynamics of space manipulator system [AIAA PAPER 90-3399] p 321 A90-47654 FLIGHT CREWS
- A case of left hypoglossal neurapraxia following G exposure in a centrifuge p 311 A90-48590 Space Station Freedom CHeCS overview --- Crew Health Care System
- [SAE PAPER 901258] p 312 A90-49327 Microbiology facilities aboard Space Station Freedom (SSF)
- [SAE PAPER 901262] p 308 A90-49330

- Heart rate and putmonary function while wearing the launch-entry crew escape suit (LES) during + Gx acceleration and simulated Shuttle launch
- [SAE PAPER 901358] p 330 A90-49391 Habitability studies for Hermes - A status of simulation and validation [SAE PAPER 901388] p 332 A90-49416
- [SAE PAPER 901388] p 332 A90-49416 FLIGHT FATIGUE
- Electrocardiogram of military aircraft pilots measured during real flight missions: Study of the variability of the cardiac rhythm in correlation with working stress
- -[ETN-90-97453] p 316 N90-28324 FLIGHT SAFETY
- Human factors and safety considerations of night vision systems flight using thermal imaging systems [AD-A223226] p 334 N90-27263
- FLIGHT SIMULATION Phase III Simplified Integrated Test (SIT) results - Space
- Station ECLSS testing [SAE PAPER 901252] p 325 A90-49321
- Operational ninety-day manned test of regenerative life support systems
- [SAE PAPER 901257] p 326 A90-49326 Human factors research in aircrew performance and
- training [AD-A221657] p 335 N90-27267 FLIGHT STRESS
- Adaptation of trained and untrained humans to natural and technogenic extreme factors under the effect of adaptogens p 310 A90-46522
- adaptogens FLIGHT STRESS (BIOLOGY)
- Electrocardiogram of military aircraft pilots measured during real flight missions: Study of the variability of the cardiac rhythm in correlation with working stress JETN-90-97453 p 316 N90-28324
- FLIGHT TRAINING Human factors research in aircrew performance and
- training {AD-A221657} p 335 N90-27267
- FLIR DETECTORS
- Human factors and safety considerations of night vision systems flight using thermal imaging systems (AD-A223226) p 334 N90-27263
- FLUID MANAGEMENT
- Sterile water for injection system for on-site production of IV fluids at Space Station Freedom HMF [SAE PAPER 901324] p 313 A90-49364
- Formulation, preparation and delivery of parenteral fluids for the Space Station Freedom Health Maintenance Facility
- [SAE PAPER 901325] p 313 A90-49365 FUEL CELLS
- System level water balance for Space Station Freedom
- [SAE PAPER 901213] p 323 A90-49288

#### G

Selective decomposition of either enantiomer or aspartic

- GAMMA RAYS
- acid irradiated with Co-60 gamma rays in the mixed aqueous solution with D- or L-alanine p 338 A90-48093 GARMENTS Garment pressurizing apparatus [AD-D014451] p 336 N90-28330 GAS ANALYSIS Atmosphere Composition Monitor for predevelopment operational system test [SAE PAPER 901256] p 326 A90-49325 GAS BEARINGS An air bearing fan for EVA suit ventilation ISAE PAPER 901432] p 333 A90-49433 GAS COMPOSITION Atmosphere Composition Monitor for predevelopment
- operational system test [SAE PAPER 901256] p 326 A90-49325 **GAS PRESSURE** Garment pressurizing apparatus [AD-D014451] p 336 N90-28330 **GLARE**
- The measurement of dark adaptation level in the presence of glare [PB90-155987] p 316 N90-28323
- GLOBULINS Stress-induced deficits of the human immune system
- p 310 A90-48331
- Energy-rich glyceric acid oxygen esters Implications for the origin of glycolysis p 339 A90-48097 GRAVITATION

Robot dynamics in reduced gravity environment p 336 N90-27333

#### GRAVITATIONAL EFFECTS

Influence of gravito-inertial force on vestibular nystagmus in man IJZF-1989-241 0.316 N90-28325

HEAT TOLERANCE

- [IZF-1989-24] p 316 N90-28325 GRAVITATIONAL PHYSIOLOGY
- Influence of gravity on cat vertical vestibulo-ocular reflex p 307 A90-49053 Earth horizontal axis rotational responses in patients with
- unilateral peripheral vestibular deficits p 318 A90-49069
- Heart rate and pulmonary function while wearing the launch-entry crew escape suit (LES) during + Gx acceleration and simulated Shuttle launch [SAE PAPER 901358] p 330 A90-49391
- [SAE PAPER 901358] p 330 490-9391 Scientific uses and technical implementation of a variable gravity centrifuge on Space Station Freedom [SAE PAPER 901360] p 330 A90-49393 [SROLIND TESTS]
  - Biosphere 2 project status Design of a closed manned
- ISAE PAPER 901233 p 324 A90-49303
- Human subjects concerns in ground based ECLSS testing Managing uncertainty in closely recycled systems
- [SAE PAPER 901251] p 325 A90-49320

# н

HABITABILITY

- Habitability studies for Hermes A status of simulation and validation
- [SAE PAPER 901388] p 332 A90-49416 HABITATS
  - Generation rates and chemical compositions of waste streams in a typical crewed space habitat [NASA-TM-102799] p 337 N90-28333
  - HAND (ANATOMY) Criteria for a recommended standard: Occupational
  - exposure to hand-arm vibration [PB90-168048] p 337 N90-28331
  - HANDLES The relationship of isometric grip strength, optimal
- dynamometer settings, and certain anthropometric factors
- [AD-A222046] p 334 N90-27264 HAZARDS
- Bioelectromagnetic effects of the Electromagnetic Pulse (EMP)
- (AD-Á221552) p 309 N90-27243 HEAD DOWN TILT
- Effects of acute hypoxia on cardiopulmonary responses to head-down tilt p 310 A90-48583
- Intraocular pressure, retinal vascular, and visual acuity changes during 48 hours of 10-deg head-down tilt p 310 A90-48586

Space Station Freedom CHeCS overview --- Crew Health

Bioelectromagnetic effects of the Electromagnetic Pulse

The integration of complex information from auditory and

The effects of blast trauma (impulse noise) on hearing:

Heart rate and pulmonary function while wearing the

Miniaturization study of heat exhausting radiator of lunar

Miniaturization study of heat exhausting radiator of lunar

A direct-interface fusible heat sink for astronaut

Physiological reactions to heat stress; quantifying the

launch-entry crew escape suit (LES) during + Gx

acceleration and simulated Shuttle launch [SAE PAPER 901358] p 3

p 334 N90-27262

p 312 A90-49327

p 309 N90-27243

p 314 N90-27245

p 316 N90-27253

p 330 A90-49391

p 322 A90-49281

p 322 A90-49281

p 333、A90-49434

p 316 N90-28326

A-5

#### HEAD-UP DISPLAYS A real-time optical 6D tracker for head-mounted display

AD-A2228841

Care System

AD-A2215521

[AD-A222686]

[AD-A221731]

HEAT EXCHANGERS

HEAT RADIATORS

[SAE PAPER 901206]

[SAE PAPER 901206]

cooling [SAE PAPER 901433]

effects of individual parameters

HEAT TOLERANCE

[IZF-1989-30]

HEART RATE

hase

base

HEAT SINKS

ISAE PAPER 9012581

visual channels under stress

A parametric study source 2

systems

HEALTH

(EMP)

HÈARING

# HEAT TRANSFER

#### HEAT TRANSFER

- A direct-interface fusible heat sink for astronaut cooling
- ISAE PAPER 9014331 n 333 A90-49434 Physical characteristics of clothing materials with regard to heat transport
- [IZF-1989-101 p.337 N90-28336 Calculation of clothing insulation and vapour resistance
- n 338 N90-28338 1176-1989-491 HELMET MOUNTED DISPLAYS
- Tracking a head-mounted display in a room-sized environment with head-mounted cameras [AD-A222545] p 335 N90-27266
- Human factors and safety considerations of night vision systems flight p 337 N90-28332
- [USAARL-89-12] HELMETS Human factors and safety considerations of night vision
- systems flight using thermal imaging systems p 334 N90-27263 AD-A2232261 HERMES MANNED SPACEPLANE
- Development of the suit enclosure of the European EVA space suit
- [SAE PAPER 901244] p 324 A90-49314 EVA life support design advancements p 324 A90-49315 [SAE PAPER 901245]
- The development of the Human Waste Collection Assembly for HERMES p 327 A90-49347 [SAE PAPER 901287]
- Habitability studies for Hermes A status of simulation and validation
- p 332 A90-49416 [SAE PAPER 901388] Hermes-crew integration aspects [SAE PAPER 901390] p 332 A90-49417
- HEURISTIC METHODS Resolution of seven-axis manipulator redundancy: A
- heuristic issue p 336 N90-27331 HIGH ALTITUDE ENVIRONMENTS
- Physiological reserves of the human organism and the high-altitude environment --- Russian bool
- p 310 A90-46625 HIGH GRAVITY ENVIRONMENTS
- Heart rate and pulmonary function while wearing the launch-entry crew escape suit (LES) during + Gx acceleration and simulated Shuttle launch [SAE PAPER 901358] p 330 A90-49391
- HISTAMINES The influence of serotonine and histamine, introduced
- in small doses, on body temperature p 306 A90-48200
- HISTOLOGY
- The effects of blast trauma (impulse noise) on hearing: A parametric study source 2 o 316 N90-27253
- [AD-A221731] HOLOGRAPHY
- Tracking a head-mounted display in a room-sized environment with head-mounted cameras AD-A222545] p 335 N90-27266
- HORMONES Hormonal changes after parabolic flight - Implications
- on the development of motion sickness p 311 A90-48588

#### HUMAN BEHAVIOR

- Rule acquisition events in the discovery of problem solving strategies [AD-A222428] p 334 N90-27265
- HUMAN BEINGS
- Effects of protracted ionizing radiation dosage on humans and animals: A brief review of selected investigations
- [AD-A222240] p 309 N90-27241 HUMAN CENTRIFUGES
- Research centrifuge accommodations on Space Station Freedom
- p 308 A90-49356 (SAF PAPER 901304) HUMAN FACTORS ENGINEERING
- Human factors in the presentation of computer-generated information Aspects of design and application in automated flight traffic
- p 321 A90-49270 Designing space habitats for human productivity ISAE PAPER 901204) p 322 A90-49279
- Human requirements for quality life in lunar base p 322 A90-49282 [SAE PAPER 901207] Human subjects concerns in ground based ECLSS
- testing Managing uncertainty in closely recycled systems [SAE PAPER 901251] p 325 A90-49320
- IVA and EVA work place design for a man-tended svstem [SAE PAPER 901415] p 332 A90-49423
- Habemsi study A study on human factors for space
- station design [SAE PAPER 901416] p 332 A90-49424

- Design considerations for future planetary space suits p 333 A90-49429 [SAE PAPER 901428] Human factors and safety considerations of night vision
- systems flight using thermal imaging systems (AD-A2232261 p 334 N90-27263
- Human factors research in aircrew performance and training [AD-A221657]
- p 335 N90-27267 The dynamics of orbital maneuvering: Design and evaluation of a visual display aid for human controllers p 336 N90-27767
- Human factors and safety considerations of night vision systems flight
- p 337 N90-28332 (USAARL-89-12) HUMAN PERFORMANCE
- Internal representation, internal model, human performance model and mental workload
- p 317 A90-47500 Eyes open versus eyes closed - Effect on human rotational responses p 318 A90-49070
- Hermes-crew integration aspects p 332 A90-49417 ISAE PAPER 9013901 Categorization and identification of simultaneous
- targets (IZF-1989-22) p 338 N90-28337
- HUMAN REACTIONS Adaptation of trained and untrained humans to natural and technogenic extreme factors under the effect of
- adaptogens p 310 A90-46522 HUMAN TOLERANCES
- Use of automated systems for the assessment of the health and the adaptive potentials of humans p 310 A90-46521
- Adaptation of trained and untrained humans to natural and technogenic extreme factors under the effect of
- adaptogens p 310 A90-46522 Physiological reserves of the human organism and the
- high-altitude environment --- Russian book p 310 A90-46625 HUMAN WASTES
- The development of the Human Waste Collection Assembly for HERMES [SAE PAPER 901287]
- p 327 A90-49347 HYDROLYSIS
- Chemical activity of simple basic peptides p 339 A90-48096
- HYDROTHERMAL SYSTEMS Report on the workshop - 'Chemical evolution and neo-abiogenesis in marine hydrothermal systems'
- p 305 A90-48091 HYGIENE
- Space Station Crew Quarters and Personal Hygiene Facility
- ISAE PAPER 9013011 n 328 A90-49353 Alternative hygiene concepts --- in manned space
- (SAF PAPER 901385) p 331 A90-49413 Hygiene and water in Space Station
- [SAE PAPER 901386] p 331 A90-49414 Generation rates and chemical compositions of waste streams in a typical crewed space habitat
- p 337 N90-28333 INASA-TM-1027991 HYPERBARIC CHAMBERS
- Altitude decompression sickness Hyperbaric therapy results in 528 cases p 311 A90-48589 HYPERTHERMIA
- The effect of hyperthermia on the cardiovascular system and acid-base composition of blood in dogs p 305 A90-46523
- HYPOXIA
- Physiological reserves of the human organism and the high-altitude environment --- Russian book p 310 A90-46625
- Effects of acute hypoxia on cardiopulmonary responses p 310 A90-48583 to head-down tilt

### 

IMAGE CONTRAST

- Effect of contrast on the perceived direction of a moving p 317 A90-49062 olaid IMAGE RECONSTRUCTION
- 3-D components of a biological neural network visualized in computer generated imagery. II - Macular neural network p 307 A90-49049 rganization IMAGING TECHNIQUES
- Human factors and safety considerations of night vision systems flight using thermal imaging systems
- p 334 N90-27263 (AD-A223226) IMMUNE SYSTEMS
- Stress-induced deficits of the human immune system p 310 A90-48331 IMMUNOASSAY
- Clinical laboratory diagnosis for space medicine p 312 A90-49331 [SAE PAPER 901263]

IN-FLIGHT MONITORING

Atmosphere Composition Monitor for predevelopment

- operational system test [SAE PAPER 901256] p 326 A90-49325 A volatile organics concentrator for use in monitoring Space Station water quality **ISAE PAPER 9013521** n 329 A90-49385 INDEXES (DOCUMENTATION) Aerospace medicine and biology: A bibliography with indexes (supplement 339) A continuing [NASA-SP-7011(339)] p 316 N90-28327 INERTIA Influence of gravito-inertial force on vestibular nystagmus in man (IZE-1989-241 p 316 N90-28325 INFORMATION PROCESSING (BIOLOGY) A network model of catecholamine effects - Gain, p 317 A90-47247 signal-to-noise ratio, and behavior Categorization and identification of simultaneous targets (IZE-1989-22) p 338 N90-28337 INFORMATION RETRIEVAL Automatic information processing and high performance skills: Application to training (AD-A2217091 p.319 N90-27259 Automatic information processing and high performance skills: Acquisition, transfer, and retention p 319 N90-27260 [AD-A221744] INFRARED IMAGERY Human factors and safety considerations of night.vision systems flight using thermal imaging systems p 334 N90-27263 (AD-A223226) INFRARED INSTRUMENTS Tracking a head-mounted display in a room-sized environment with head-mounted cameras [AD-A222545] p 335 N90-27266 INTERFACES Medical information BUS - Integrated monitoring for the HMF of Space Station Freedom SAE PAPER 901328 p 313 A90-49367 INTRAOCULAR PRESSURE Intraocular pressure, retinal vascular, and visual acuity changes during 48 hours of 10-deg head-down tilt p 310 A90-48586 INTRAVEHICULAR ACTIVITY Space Station Crew Quarters and Personal Hygiene Facility SAE PAPER 901301 p.328 A90-49353 IVA and EVA work place design for a man-tended evstern ISAE PAPER 9014151 n 332 A90-49423 IODINE Recent experiences with iodine water disinfection in Shuttle SAE PAPER 901356 p 329 A90-49389 IODINE COMPOUNDS Influence of iodine on the treatment of spacecraft humidity condensate to produce potable water SAE PAPER 901355 p 329 A90-49388 ION EMISSION Nuclear reaction effects in conventional risk assessment p 311 A90-49065 for energetic ion exposure ION EXCHANGING Did membrane electrochemistry precede translation? p 305 A90-46652 IONIZING RADIATION Recent developments in estimates of cancer risk from ionizing radiation [SAE PAPER 901344] n 313 A90-49379 Effects of protracted ionizing radiation dosage on humans and animals: A brief review of selected investigations (AD-A222240) p 309 N90-27241 Effects of ionizing radiation on the performance of selected tactical combat crews AD-A2228801 p 315 N90-27248 IRON COMPOUNDS The case for the chemoautotrophic origin of life in an
- p 339 A90-48099 iron-sulfur world IRRADIATION Effects of protracted ionizing radiation dosage on
- humans and animals: A brief review of selected investigations
- [AD-A222240] p 309 N90-27241 ISOMERS
- Superhelicity and DNA radiation sensitivity [SAE PAPER 901349] p 308 A90-49383

- JAPANESE SPACE PROGRAM Japanese research activities of life support system
- (SAE PAPER 901205) p 322 A90-49280 Status of JEM ECLSS design
- p 322 A90-49284 [SAE PAPER 901209]

JET LAG

Melatonin, light and, circadian cycles p 318 N90-27256 AD-A2231961 JUDGMENTS

Conference on The Perception of Structure Program and Abstracts

AD-A2224371 p 319 N90-28328

LAUNCH ESCAPE SYSTEMS

Heart rate and pulmonary function while wearing the launch-entry crew escape suit (LES) during + Gx acceleration and simulated Shuttle launch p 330 A90-49391 [SAE PAPER 901358]

LEAKAGE

- Garment pressurizing apparatus IAD-D0144511 n 336 N90-28330
- Rule acquisition events in the discovery of problem solving strategies
- IAD-A2224281 p 334 N90-27265 The effects of training on errors of perceived direction in perspective displays

[NASA-TM-102792] p 319 N90-28329 LENSES

Tracking a head-mounted display in a room-sized environment with head-mounted cameras p 335 N90-27266 [AD-A222545]

LIFE SCIENCES Origins of life - An operational definition

- p 339 A90-48095 LIFE SUPPORT SYSTEMS
- Japanese research activities of life support system p 322 A90-49280 ISAE PAPER 9012051 Water recycling system for CELSS environment in
- space [SAE PAPER 901208] p 322 A90-49283
- Status of JEM ECLSS design [SAE PAPER 901209] p 322 A90-49284
- Past and present environmental control and life support systems on manned spacecraft [SAE PAPER 901210] p 323 A90-49285
- Space Station Freedom Environmental Control and Life Support System design - A status report
- p 323 A90-49286 [SAE PAPER 901211] Optimal configuration and operation for the Space
- Shuttle Freedom ECLSS [SAE PAPER 901212] p 323 A90-49287
- System level water balance for Space Station Freedom [SAE PAPER 901213] p 323 A90-49288
- Life support function and technology analysis for future missions
- [SAE PAPER 901216] p 323 A90-49291 Quality assessment of plant transpiration water
- ISAE PAPER 9012301 n 323 A90-49301 Engineering testbed for biological water/air reclamation and recycling [SAE PAPER 901231]
- p 324 A90-49302 Biosphere 2 project status - Design of a closed manned terrestrial ecological system
- [SAE PAPER 901233] p 324 A90-49303 EVA life support design advancements
- [SAE PAPER 901245] p 324 A90-49315 Life support - Thoughts on the design of safety systems
- [SAE PAPER 901248] p 325 A90-49318 Pumping equipment of autonomous inhabited systems
- [SAE PAPER 901250] p 325 A90-49319 Human subjects concerns in ground based ECLSS testing - Managing uncertainty in closely recycled
- systems SAE PAPER 901251 p 325 A90-49320 Phase III Simplified Integrated Test (SIT) results - Space
- Station ECLSS testing [SAE PAPER 901252] p 325 A90-49321
- Test bed design for evaluating the Space Station ECLSS Water Recovery System [SAE PAPER 901253] p 325 A90-49322
- Facility for generating crew waste water product for ECLSS testing [SAE PAPER 901254]
- p 325 A90-49323 Atmosphere Composition Monitor for predevelopment operational system test
- [SAE PAPER 901256] p 326 A90-49325 Operational ninety-day manned test of regenerative life support systems
- [SAE PAPER 901257] p 326 A90-49326 Application of a comprehensive G189A ECLSS model
- in assessing specific Space Station conditions [SAE PAPER 901265] p 326 p 326 A90-49333

Computer aided system engineering and analysis (CASE/A) modeling package for ECLS systems - An overview

- [SAE PAPER 901267] p 327 A90-49336 A prototype computer-aided modelling tool for life-support system models
- ISAE PAPER 9012691 n 327 A90-49337 ECLS technology development programme - Results
- and further activitie [SAF PAPER 901289] p 327 A90-49349
- Design definition of the Space Station Freedom Galley and Wardroom subsystems and their effect on Space Station Environmental Systems p 327 A90-49351
- [SAE PAPER 901299]
- Space Station Freedom science support equipment ISAE PAPER 901302 | p 328 A90-49354 Research centrifuge accommodations on Space Station
- Freedom ISAE PAPER 9013041 p 308 A90-49356
- Design and evaluation of an electronic stethoscope system for the Space Station Freedom HMF
- (SAE PAPER 901323) p 313 A90-49363 Sterile water for injection system for on-site production of IV fluids at Space Station Freedom HMF
- (SAE PAPER 901324) o 313 A90-49364 Formulation, preparation and delivery of parenteral fluids for the Space Station Freedom Health Maintenance
- Facility [SAE PAPER 901325] p 313 A90-49365 Computer simulation of a regenerative life support
- system for a lunar base [SAE PAPER 901329] p 328 A90-49368
- Oxidation kinetics of model compounds of metabolic waste in supercritical water ISAE PAPER 9013331 p 328 A90-49371
- Space Station Freedom viewed as a 'tight building ISAE PAPER 9013821 p 331 A90-49410 Identifying atmospheric monitoring needs for Space
- Station Freedom p 331 A90-49411 (SAE PAPER 901383)
- Hermes-crew integration aspects p 332 A90-49417 [SAE PAPER 901390]
- Common approach for planetary habitation systems implementation
- [SAE PAPER 901417] p 332 A90-49425 A direct-interface fusible heat sink for astronaut cooling
- [SAE PAPER 901433] SAE PAPER 901433] p 333 A90-49434 Space Station Freedom ECLSS: A step toward autonomous regenerative life support systems
- p 335 N90-27297 Generation rates and chemical compositions of waste
- streams in a typical crewed space habitat p 337 N90-28333 [NASA-TM-102799] LIGHT (VISIBLE RADIATION)
- Melatonin, light and, circadian cycles
- p 318 N90-27256 IAD-A2231961 LINKS (MATHEMATICS)
- Superhelicity and DNA radiation sensitivity p 308 A90-49383 [SAE PAPER 901349] LIQUID CHROMATOGRAPHY
- Liquid Chromatography/Mass Spectrometry A new technique for water recovery system testing [SAE PAPER 901255] p 326 A90-49324
- LIQUID COOLING
- Integrated air/water cooling concepts for space laboratory modules
- [SAE PAPER 901370] p 330 A90-49400 Work enhancement and thermal changes during intermittent work in cool water after carbohydrate loading
- IAD-A2228771 p 315 N90-27247
- LIQUID CRYSTALS Possible amplification of enantiomer excesses through structural properties of liquid crystals - A model for origin of optical activity in the biosphere? p 338 A90-48094
- LIQUID-GAS MIXTURES Detection of gas loading of the water onboard Space Station Freedom
- p 329 A90-49386 [SAE PAPER 901353] LIVER
- The chronic effect of an electrostatic field on certain biochemical indices of tissues p 305 A90-46524 LONG DURATION SPACE FLIGHT
- Human exercise capabilities in space
- [SAE PAPER 9012001 p 312 A90-49276 Water recycling system for CELSS environment in
- space [SAE PAPER 901208] p 322 A90-49283
- Plant biology research on 'LifeSat' p 307 A90-49299 [SAE PAPER 901227]
- LifeSat Radiation research p 307 A90-49300 [SAE PAPER 901228]
- Quality assessment of plant transpiration water [SAE PAPER 901230] p 323 A90-49301

## MAN MACHINE SYSTEMS

Clinical laboratory diagnosis for space medicine ISAE PAPER 9012631 p 312 A90-49331

Deep-space radiation exposure analysis for solar cycle XXI (1975-1986)

- [SAE PAPER 9013471 p 314 A90-49381 Computer simulation of cardiovascular changes during extended duration space flights
- [SAE PAPER 901359] p 314 A90-49392 Crew selection, productivity and well-being for human
- exploration missions ISAE PAPER 9013621 p 318 A90-49395
- Generation rates and chemical compositions of waste treams in a typical crewed space habitat INASA-TM-1027991 p 337 N90-28333
- LONG TERM EFFECTS Crew selection, productivity and well-being for human
- exploration missions ISAE PAPER 9013621 p 318 A90-49395
- LOW COST Creature co-op: Achieving robust remote operations with a community of low-cost robots p 336 N90-27303
- LOW TEMPERATURE
- Low-temperature thermal control for a lunar base [SAE PAPER 901242] p 324 A90-4 p 324 A90-49312 LUMINANCE
- The effects of luminance boundaries on color perception
- AD-A221544 p 315 N90-27251 LUMINOUS INTENSITY
- Human factors and safety considerations of night vision systems flight using thermal imaging systems
- IAD-A2232261 n 334 N90-27263 LUNAR BASES
- Miniaturization study of heat exhausting radiator of lunar hase
- ISAE PAPER 9012061 p 322 A90-49281 Human requirements for quality life in lunar base
- [SAE PAPER 901207] p 322 A90-49282 Low-temperature thermal control for a lunar base
- SAE PAPER 9012421 p 324 A90-49312 Computer simulation of a regenerative life support system for a lunar base [SAE PAPER 901329]

implementation

ISAE PAPER 9014171

and Martian surfaces

LUNAR ENVIRONMENT

exploration

SAE PAPER 9014271

(SAE PAPER 901243)

testing [SAE PAPER 901332]

and Martian surfaces

MACHINE LEARNING

solving strategies

A parametric study source 2 [AD-A221731]

[SAE PAPER 901260]

SAE PAPER 901299

SAF PAPER 9013001

MAN MACHINE SYSTEMS

SAE PAPER 901203

MAN ENVIRONMENT INTERACTIONS

Development of the Space Environmental Health System

Station Environmental Systems

Refrigerator/Freezer and Freezer

Development of the Space

Internal representation, internal

performance model and mental workload

A vision-based telerobotic control station

1 40-4222428

MALFUNCTIONS .

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MAMMALS

[SAE PAPER 901427]

LUNAR SURFACE

LUNAR EXPLORATION

Common approach for planetary habitation systems

Requirements for extravehicular activities on the lunar

Active thermal control systems for lunar and Martian

Advanced air revitalization system modeling and

Requirements for extravehicular activities on the lunar

Μ

Rule acquisition events in the discovery of problem

A model for a space shuttle safing and failure-detection

The effects of blast trauma (impulse noise) on hearing:

Design definition of the Space Station Freedom Galley

Work/control stations in Space Station weightlessness

and Wardroom subsystems and their effect on Space

p 328 A90-49368

p 332 A90-49425

p 333 A90-49428

p 324 A90-49313

p 328 A90-49370

p 333 A90-49428

p 334 N90-27265

p 336 N90-27314

p 316 N90-27253

Station Freedom

p 312 A90-49329

p 327 A90-49351

Station Freedom

p 328 A90-49352

model, human

p 317 A90-47500

p 322 A90-49278

p 336 N90-27311

A-7

# MAN TENDED FREE FLYERS

#### MAN TENDED FREE FLYERS

- IVA and EVA work place design for a man-tended system (SAE PAPER 901415) p 332 A90-49423
- MAN-COMPUTER INTERFACE presentation factors the Human in of
- computer-generated information Aspects of design and application in automated flight traffic p 321 A90-49270
- A real-time optical 6D tracker for head-mounted display systems
- p 334 N90-27262 [AD-A222884] A model for a space shuttle safing and failure-detection p 336 N90-27314 expert

#### MANAGEMENT PLANNING

- Agent independent task planning p 335 N90-27276 MANIPULATORS
- The kinematics and dynamics of space manipulators p 320 A90-46399 The virtual manipulator approach Three-dimensional camera space manipulation
- p 320 A90-46400 Trajectory planning for a space manipulator [AAS PAPER 89-440] p 320 A90-46827
- On dynamics and control of multi-link flexible space maninulators [AIAA PAPER 90-3396] p 320 A90-47651
- Dynamics and positioning control of space robot with flexible manipulators
- [AIAA PAPER 90-3397] p 320 A90-47652 Model-based iterative learning control of Space-Shuttle manipulator
- [AIAA PAPER 90-3398] p 320 A90-47653 A pretiminary study on experimental simulation of dynamics of space manipulator system
- [AIAA PAPER 90-3399] p 321 A90-47654 The intrinsic approach to space robotic manipulators
- [AIAA PAPER 90-3431] p 321 A90-47684 Capture control for manipulator arm of free-flying space roho
- [AIAA PAPER 90-3432] p 321 A90-47685 Smart end effector for dexterous manipulation in enace
- [AIAA PAPER 90-3434] p 321 A90-47687 Agent independent task planning p 335 N90-27276
- Simulation-based intelligent robotic agent for Space p 335 N90-27298 Station Freedom A vision-based telerobotic control station
- p.336 N90-27311 Resolution of seven-axis manipulator redundancy: A
- p 336 N90-27331 heuristic issue Robot dynamics in reduced gravity environment p 336 N90-27333

#### MANNED MARS MISSIONS

- Common approach for planetary habitation systems implementation
- [SAE PAPER 901417] p 332 A90-49425 Spacecraft accommodation strategies for manned Mars missions
- p 333 A90-49426 [SAE PAPER 901418] Requirements for extravehicular activities on the lunar and Martian surfaces
- p 333 A90-49428 [SAE PAPER 901427] MANNED ORBITAL LABORATORIES
- Common approach for planetary habitation systems implementation [SAE PAPER 901417] p 332 A90-49425
- MANNED SPACE FLIGHT Operational ninety-day manned test of regenerative life
- support systems [SAE PAPER 901257] p 326 A90-49326
- Space Station requirements for in-flight exercise countermeasures [SAF PAPER 901259] p 312 A90-49328
- Clinical laboratory diagnosis for space medicine p 312 A90-49331 [SAE PAPER 901263]
- Critical technologies Spacecraft habitability p 331 A90-49412 [SAE PAPER 901384]
- Alternative hygiene concepts --- in manned space flight p 331 A90-49413 ISAF PAPER 9013851
- MANNED SPACECRAFT Past and present environmental control and life support
- systems on manned spacecraft [SAE PAPER 901210] p 323 A90-49285
- Life support function and technology analysis for future missions [SAE PAPER 901216] p 323 A90-49291
- Water recycling in space [SAE PAPER 901247] p 325 A90-49317 Space Station Freedom contamination requirements and predictions
- p 332 A90-49418 [SAE PAPER 901408] MANUAL CONTROL
- Manual control aspects of Space Station docking maneuvers [SAE PAPER 901202] p 321 A90-49277

A-8

- The relationship of isometric grip strength, optimal dynamometer settings, and certain anthropometric factors
- (AD-A222046) p 334 N90-27264 MARINE CHEMISTRY
- Report on the workshop 'Chemical evolution and neo-abiogenesis in marine hydrothermal syste p 305 A90-48091
- MARS ENVIRONMENT
- Active thermal control systems for lunar and Martian exploration
- [SAE PAPER 901243] p 324 A90-49313 MARS PROBES
- Advanced air revitalization system modeling and testing
- [SAE PAPER 901332] p 328 A90-49370 MARS SURFACE
- Requirements for extravehicular activities on the lunar and Martian surfaces (SAE PAPER 901427) p 333 A90-49428
- MASKING Binaural masking: An analysis of models
- p 315 N90-27252 [AD-A221668] MASS SPECTROSCOPY
- Chemical structure of a prebiotic analog of adenosine p 305 A90-46654
- Liquid Chromatography/Mass Spectrometry A new technique for water recovery system testing [SAE PAPER 901255] p 326
- p 326 A90-49324 MATHEMATICAL MODELS
- The kinematics and dynamics of space manipulators p 320 A90-46399 The virtual manipulator approach Physical characteristics of clothing materials with regard to heat transport
- [IZF-1989-10] p 337 N90-28336 Calculation of clothing insulation and vapour resistance
- [IZF-1989-491 p 338 N90-28338 MÉDICAL EQUÍPMENT
- Clinical laboratory diagnosis for space medicine [SAE PAPER 901263] p 312 A90 p 312 A90-49331
- MEDICAL SERVICES Sterile water for injection system for on-site production
- of IV fluids at Space Station Freedom HMF [SAE PAPER 901324] p 313 A90-49364
- Formulation, preparation and delivery of parenteral fluids for the Space Station Freedom Health Maintenance Facility [SAE PAPER 901325]
- p 313 A90-49365 Medical information BUS - Integrated monitoring for the HMF of Space Station Freedom
- [SAE PAPER 901328] p 313 A90-49367 European Space Station health care system concept
- [SAE PAPER 901387] p 332 A90-49415 MENTAL PERFORMANCE
- Real-time measurement of mental workload using sychophysiological measures
- p 319 N90-27258 [AD-A221462] Automatic information processing and high performance skills: Acquisition, transfer, and retention
- p 319 N90-27260 [AD-A221744] METABOLIC WASTES
- Oxidation kinetics of model compounds of metabolic waste in supercritical water
- [SAE PAPER 901333] p 328 A90-49371 METEORITE COLLISIONS
- Impact constraints on the environment for chemical evolution and the continuity of life p 339 A90-48101 MICROBIOLOGY
- Microbiology facilities aboard Space Station Freedom (SSF)
- [SAE PAPER 901262] p 308 A90-49330 MINIATURIZATION
- Miniaturization study of heat exhausting radiator of lunar hase [SAE PAPER 901206] p 322 A90-49281
- MISSION PLANNING
- Life support function and technology analysis for future missions
- [SAE PAPER 901216] p 323 A90-49291 MODELS Neurobehavioral effects of carbon monoxide (CO)
- exposure in humans: Elevated carboxyhemoglobin (COHb) and cerebrovascular responses p 314 N90-27246 [AD-A222840]
- MOISTURE CONTENT
- Application of a comprehensive G189A ECLSS model in assessing specific Space Station conditions
- [SAE PAPER 901265] p 326 A90-49333 Influence of iodine on the treatment of spacecraft humidity condensate to produce potable wate
- [SAE PAPER 901355] p 329 A90-49388 MOLECULAR BIOLOGY
- The 1989 Gordon Research Conference on Chronobiology [AD-A221972]
  - p 309 N90-28322

- MOLECULAR STRUCTURE
- Chemical structure of a prebiotic analog of adenosine p 305 A90-46654 MONKEYS

SUBJECT INDEX

- Effects of competition on video-task performance in monkeys (Macaca mulatta) p 317 A90-49039
- MONOCULAR VISION Non-linear analysis of visual cortical neurons
- [AD-A221543] p 315 N90-27250 MOTION PERCEPTION
- Effect of contrast on the perceived direction of a moving olaid p 317 A90-49062
- MOTION SICKNESS The susceptibility of rhesus monkeys to motion
- p 306 A90-48585 sickness Hormonal changes after parabolic flight - Implications
- on the development of motion sickness p 311 A90-48588
- BU 24969-induced emesis in the cat 5-HT1 sites other than 5-HT1A, 5-HT1B or 5-HT1C implicated p 307 A90-49041

#### MOTION SIMULATION

NASA SPACE PROGRAMS

[SAE PAPER 901380]

exposure in a centrifuge

exposure in a centrifuge

signal-to-noise ratio, and behavior

NECK (ANATOMY)

NERVOUS SYSTEM

rganization

NEURAL NETS

organization

AD-A221543

[AD-A221481]

simulations

1AD-A2232261

[AD-A223226]

[PB90-155987]

systems flight

[USAARL-89-12]

NOISE THRESHOLD

NONLINEAR FILTERS

[AD-A221668]

[AD-A221543]

NORADRENALINE

resence of glare

NIGHT VISION

NEUROPHYSIOLOGY

NEUROTRANSMITTERS

[SAE PAPER 901246]

**NIGHT FLIGHTS (AIRCRAFT)** 

NEURONS

NERVES

- Curvature estimation in orientation selection [AD-A221481] p 315 N90-27249 MUSCULAR STRENGTH
- The relationship of isometric grip strength, optimal dynamometer settings, and certain anthropometric
- factors [AD-A222046] p 334 N90-27264
- MUSCULOSKELETAL SYSTEM
- Changes in geometrical and biomechanical properties of immature male and female rat tibia p 306 A90-48587

Application of the pentaiodide strong base resin disinfectant to the U.S. space program

A case of left hypoglossal neurapraxia following G

A case of left hypoglossal neurapraxia following G

3-D components of a biological neural network visualized

A network model of catecholamine effects - Gain,

3-D components of a biological neural network visualized

RU 24969-induced emesis in the cat - 5-HT1 sites other

Emulation of the Eva Soviet suit for neutral buoyancy

Human factors and safety considerations of night vision

Human factors and safety considerations of night vision

The measurement of dark adaptation level in the

Human factors and safety considerations of night vision

Participation of cerebral noradrenergic structures in

in computer generated imagery. II - Macular neural network

Non-linear analysis of visual cortical neurons

Curvature estimation in orientation selection

than 5-HT1A, 5-HT1B or 5-HT1C implicated

systems flight using thermal imaging systems

systems flight using thermal imaging systems

Binaural masking: An analysis of models

Non-linear analysis of visual cortical neurons

thermoregulation during the adaptation to cold

NEUTRAL BUOYANCY SIMULATION

in computer generated imagery. II - Macular neural network

p 331 A90-49408

p 311 A90-48590

p 311 A90-48590

p 307 A90-49049

p 317 A90-47247

p 307 A90-49049

p 315 N90-27250

p 315 N90-27249

p 307 A90-49041

p 324 A90-49316

p 334 N90-27263

p 334 N90-27263

p 316 N90-28323

p 337 N90-28332

p 315 N90-27252

p 315 N90-27250

p 306 A90-48199

# Ν

# SUBJECT INDEX

#### NUCLEAR EXPLOSIONS

Bioelectromagnetic effects of the Electromagnetic Pulse (EMP) p 309 N90-27243 IAD-A2215521

- NUCLEAR MAGNETIC RESONANCE Chemical structure of a prebiotic analog of adenosine
- p 305 A90-46654 NUCLEAR REACTIONS
- Risk assessment methodologies for target fragments produced in high-energy nucleon reactions p 312 A90-49066
- NUCLEAR WEAPONS

Effects of ionizing radiation on the performance of selected tactical combat crews IAD-A2228801 p 315 N90-27248

- NUCLEONS
- Risk assessment methodologies for target fragments produced in high-energy nucleon reactions p 312 A90-49066
- NUCLEOSIDES
- Template-directed oligomerization of 5-prime-deoxy 5-nucleosideacetic acid derivatives p 339 A90-48098 NUCLEOTIDES
- Chemical structure of a prebiotic analog of adenosine p 305 A90-46654
- Chemical activity of simple basic peptides A90-48096 p 339
- NUTRIENTS
- Survival of pathogenic bacteria under nutrient starvation conditions --- aboard orbiting space stations [SAE PAPER 901381] p 308 A90-49409

0

#### OCCIPITAL LOBES

- Evoked potentials during periods of look fixation and periods of saccadic eye movement in humans p 309 A90-46520
- OCCUPATIONAL DISEASES
- Criteria for a recommended standard: Occupational exposure to hand-arm vibration
- [PB90-168048] p 337 N90-28331 OCULOGRAVIC ILLUSIONS
- Visual-vestibular interaction in humans durina p 317 A90-49048 earth-horizontal axis rotation OCULOMETERS
- Cockpit Ocular Recording System (CORS) [NASA-CR-4281] p 314 p 314 N90-27244
- OLIGOMERS

Chemical activity of simple basic peptides

- p 339 A90-48096 Template-directed oligomerization of 5-prime-deoxy 5-nucleosideacetic acid derivatives p 339 A90-48098 OPERATOR PERFORMANCE
- The integration of complex information from auditory and visual channels under stress [AD-A222686] n 314 N90-27245
- The measurement of dark adaptation level in the presence of glare p 316 N90-28323 PB90-1559871
- **OPERATORS (PERSONNEL)** internal model, human Internal representation, performance model and mental workload
- p 317 A90-47500 **OPTICAL ACTIVITY**
- Possible amplification of enantiomer excesses through structural properties of liquid crystals - A model for origin of optical activity in the biosphere? p 338 A90-48094 OPTICAL TRACKING
- Visual mechanisms and predictors of far field visual task performance p 311 A90-48700 OPTIMIZATION
- Optimal configuration and operation for the Space Shuttle Freedom ECLSS
- SAE PAPER 901212] p 323 A90-49287 Constraints and rationale for Space Station Freedom Habitation and laboratory module topology
- ISAE PAPER 901297] p 327 A90-49350 **ORBITAL MANEUVERS** The dynamics of orbital maneuvering: Design and
- evaluation of a visual display aid for human controllers p 336 N90-27767
- **ORGANIC COMPOUNDS**
- New total organic carbon analyzer [SAE PAPER 901354] p 329 A90-49387
- ORGANIC LIQUIDS A volatile organics concentrator for use in monitoring Space Station water quality
- [SAE PAPER 901352] p 329 A90-49385 ORGANIC SOLIDS
- A volatile organics concentrator for use in monitoring Space Station water quality
- p 329 A90-49385 [SAE PAPER 901352]

- ORTHOSTATIC TOLERANCE
- Use of automated systems for the assessment of the health and the adaptive potentials of humans p 310 A90-46521
- OTOLITH ORGANS interaction Visual-vestibular in humans during
- p 317 A90-49048 earth-horizontal axis rotation OXIDATION Oxidation kinetics of model compounds of metabolic
- waste in supercritical water p 328 A90-49371 ISAE PAPER 9013331
- **OXYGEN CONSUMPTION**
- Work enhancement and thermal changes during intermittent work in cool water after carbohydrate loading
- [AD-A222877] p 315 N90-27247 **OXYGEN SUPPLY EQUIPMENT**
- Integrated model of G189A and Aspen-plus for the transient modeling of extravehicular activity atmospheric control systems [SAE PAPER 901268]
- p 326 A90-49335

# Ρ

- PARABOLIC FLIGHT Hormonal changes after parabolic flight - Implications on the development of motion sickness p 311 A90-48588
- PARTICLE COLLISIONS
- Risk assessment methodologies for target fragments produced in high-energy nucleon reactions p 312 A90-49066
- PATHOGENS
- Survival of pathogenic bacteria under nutrient starvation conditions --- aboard orbiting space stations [SAE PAPER 901381] p 308 A90-49409 PATTERN RECOGNITIÓN
- Conference on The Perception of Structure Program and Abstracts
- p 319 N90-28328 [AD-A222437] Categorization and identification of simultaneous targets
- p 338 N90-28337 1 ZF-1989-221 PEPTIDES
- Chemical activity of simple basic peptides p 339 A90-48096
- PERCEPTION Conference on The Perception of Structure Program and
- Abstracts [AD-A222437] p 319 N90-28328
- PERCEPTUAL ERRORS
- The effects of training on errors of perceived direction in perspective displays
- [NASA-TM-102792] p 319 N90-28329 PERFORMANCE PREDICTION
- LSOPP II A program for advanced EVA system nodeling and trade studies p 326 A90-49332
- [SAE PAPER 901264] Cross-validation of experimental USAF pilot training performance models
- [AD-A222253] p 319 N90-27257 PERFORMANCE TESTS
- Garment pressurizing apparatus [AD-D014451] p 336 N90-28330 PERMITTIVITY
- Accurate determination of the complex permittivity of biological tissue at 90 GHz, 70 GHz, and over a broad hand around 35 GHz
- [AD-A222062] p 309 N90-27240 PERSONNEL
- The integrated area measure of visual endogenous ERPs: Relation to cognitive workload and hemisphere [AD-A223191] p 318 N90-27255
- PERSONNEL DEVELOPMENT
- Automatic information processing and high performance skills: Application to training [AD-A221709] p 319 N90-27259
- PHOTODIODES
- Tracking a head-mounted display in a room-sized environment with head-mounted cameras [AD-A222545] p 335 N90-27266
- PHOTOSYNTHESIS
- A generalized photosynthetic model for plant growth within a closed artificial environment p 308 A90-49369 [SAE PAPER 901331]
- PHYSICAL EXERCISE Human exercise capabilities in space
- [SAE PAPER 901200] p 312 A90-49276 PHYSICAL FITNESS
- Adaptation of trained and untrained humans to natural and technogenic extreme factors under the effect of adaptogens p 310 A90-46522
- Human exercise capabilities in space [SAE PAPER 901200] p 312 A90-49276

The relationship of isometric grip strength, optimal dynamometer settings, and certain anthropometric factors

POTENTIAL THEORY

- [AD-A222046] p 334 N90-27264 Physiological reactions to heat stress; quantifying the effects of individual parameters [IZF-1989-30] p.316 N90-28326
- PHYSIOLOGICAL FACTORS
- Development of the Space Environmental Health System Station Freedom [SAE PAPER 901260] p 312 A90-49329
- PHYSIOLOGICAL RESPONSES
- Use of automated systems for the assessment of the health and the adaptive potentials of humans
- p 310 A90-46521 Physiological reserves of the human organism and the high-altitude environment --- Russian book
- p 310 A90-46625 Earth horizontal axis rotational responses in patients with unilateral peripheral vestibular deficits
- p 318 A90-49069 Physiological reactions to heat stress; quantifying the effects of individual parameters
- p 316 N90-28326 (17E-1989-30) PHYSIOLOGICAL TESTS
- Electrocardiogram of military aircraft pilots measured during real flight missions: Study of the variability of the cardiac rhythm in correlation with working stress
- [ETN-90-97453] p 316 N90-28324 PILOT PERFORMANCE
- Cockpit Ocular Recording System (CORS)

Melatonin, light and, circadian cycles

fabrication of planetary space suit structures

Quality assessment of plant transpiration water [SAE PAPER 901230] p 323 A90

within a closed artificial environment [SAE PAPER 901331]

AD-A222253]

PILOT SELECTION

AD-A2222531

AD-A2222531

[AD-A223196]

PLANETARY BASES

implementation

SAE PAPER 901417

PLANETARY SUBFACES

[SAE PAPER 901428]

[SAE PAPER 901429]

and recycling [SAE PAPER 901231]

solutions of cvanides

modeling and trade studies [SAE PAPER 901264]

and Martian surfaces [SAE PAPER 901427]

POSITION (LOCATION)

flexible manipulators

[AIAA PAPER 90-3397]

[SAE PAPER 901353]

[SAE PAPER 901355]

POTENTIAL THEORY

[AD-A223191]

[AD-A221481]

POTABLE WATER

Station Freedom

PLANTS (BOTANY)

POLYMERIZATION

PLANTING

PINEAL GLAND

PILOT TRAINING

performance models

performance models

p 314 N90-27244 [NASA-CR-4281] Cross-validation of experimental USAF pilot training performance models

Cross-validation of experimental USAF pilot training

Cross-validation of experimental USAF pilot training

Common approach for planetary habitation systems

Design considerations for future planetary space suits

A methodology for choosing candidate materials for the

A generalized photosynthetic model for plant growth

Engineering testbed for biological water/air reclamation

Radiation-induced polymerization in dilute aqueous

Template-directed oligomerization of 5-prime-deoxy

LSOPP II - A program for advanced EVA system

Requirements for extravehicular activities on the lunar

Dynamics and positioning control of space robot with

Detection of gas loading of the water onboard Space

Influence of iodine on the treatment of spacecraft

The integrated area measure of visual endogenous

ERPs: Relation to cognitive workload and hemisphere

Curvature estimation in orientation selection

humidity condensate to produce potable water

POSITIONING DEVICES (MACHINERY)

5-nucleosideacetic acid derivatives p 339 A90-48098 PORTABLE LIFE SUPPORT SYSTEMS

p 319 N90-27257

p.319 N90-27257

p 319 N90-27257

p 318 N90-27256

p 332 A90-49425

p 333 A90-49430

p 308 A90-49369

p 323 A90-49301

p 324 A90-49302

p 305 A90-46655

p 326 A90-49332

p 333 A90-49428

p 315 N90-27249

p 320 A90-47652

p 329 A90-49386

p 329 A90-49388

p 318 N90-27255

A-9

A90-49429

p 333

# PRESSURE BREATHING

#### PRESSURE BREATHING

Positive pressure breathing for acceleration protection and its role in prevention of inflight G-induced loss of p 311 A90-48591 consciousne

#### PRESSURE DEPENDENCE

- Toxicological aspects of fire onboard aircrafts: Role of the pressurization and ventilation in the cockpit p 337 N90-28335 [ETN.90.97452] - -
- PRESSURE SUITS
- Heart rate and pulmonary function while wearing the launch-entry crew escape suit (LES) during + Gx acceleration and simulated Shuttle launch
- p 330 A90-49391 [SAE PAPER-901358] PRESSURIZED CABINS Constraints and rationale for Space Station Freedom
- Habitation and laboratory module topology p 327 A90-49350 [SAE PAPER 901297]
- PRESSURIZING
- Garment pressurizing apparatus p 336 N90-28330 140-00144511 PRIMITIVE EARTH ATMOSPHERE
- Abiotic synthesis of amino acids and imidazole by proton irradiation of simulated primitive earth atmospheres p 338 A90-48092
- Energy-rich glyceric acid oxygen - Implications for the origin of glycolysis PROBLEM SOLVING p 339 A90-48097
- Rule acquisition events in the discovery of problem solving strategies p 334 N90-27265 IAD-A2224281
- PRODUCT DEVELOPMENT Scope and conception of the pilot support system
- ASPIO [LRT-WE-13-FB-88-1] p 337 N90-28334
- PRODUCTIVITY
- Designing space habitats for human productivity [SAE PAPER 901204] p 322 A90 p 322 A90-49279 PROSTHETIC DEVICES
- Rotationally actuated prosthetic helping hand [NASA-CASE-MFS-28426-1] p 334 N p 334 N90-27261 **PROTECTIVE CLOTHING**
- Physical characteristics of clothing materials with regard to heat transport
- (IZF-1989-10) p.337 N90-28336 PROTEINS
- Pseudomonas diagnostic assay n 308 N90-27239 [NASA-CASE-NPO-17653-1-CU] PROTON IRRADIATION
- Abiotic synthesis of amino acids and imidazole by proton irradiation of simulated primitive earth atmospheres p 338 A90-48092
- PROTOTYPES
- A prototype computer-aided modelling tool for life-support system models [SAE PAPER 901269] p 327 A90-49337
- PSEUDOMONAS Survival of pathogenic bacteria under nutrient starvation
- conditions --- aboard orbiting space stations [SAE PAPER 901381] p 308 A90-49409 Pseudomonas diagnostic assay
- p 308 N90-27239 [NASA-CASE-NPO-17653-1-CU] PSYCHOLOGICAL EFFECTS
- Crew selection, productivity and well-being for human exploration missions
- [SAE PAPER 901362] p 318 A90-49395 PSYCHOLOGICAL TESTS Cross-validation of experimental USAF pilot training
- performance models [AD-A222253] p 319 N90-27257
- PSYCHOLOGY

A-10

- The integrated area measure of visual endogenous ERPs: Relation to cognitive workload and hemisphere p 318 N90-27255 [AD-A223191] PSYCHOMOTOR PERFORMANCE
- Effects of competition on video-task performance in monkeys (Macaca mulatta) p 317 A90-49039 PSYCHOPHYSICS
- Curvature estimation in orientation selection [AD-A221481] p 315 N90-27249
- PSYCHOPHYSIOLOGY The effects of luminance boundaries on color perception
- [AD-A221544] p 315 N90-27251 Real-time measurement of mental workload using
- psychophysiological measures AD-A2214621 p 319 N90-27258
- PULMONARY FUNCTIONS Effects of acute hypoxia on cardiopulmonary responses p 310 A90-48583 to head-down tilt
- Heart rate and pulmonary function while wearing the launch-entry crew escape suit (LES) during + Gx acceleration and simulated Shuttle launch p 330 A90-49391 [SAE PAPER 901358]
- PUMPS Pumping equipment of autonomous inhabited systems p 325 A90-49319 **ISAE PAPER 9012501**

R

**RADIATION DAMAGE** 

- Superhelicity and DNA radiation sensitivity [SAE PAPER 901349] p 308 A90-49383 Mechanisms of microwave induced damage in biologic materials
- [AD-A222454] p 309 N90-27242 RADIATION DOSAGE
- Nuclear reaction effects in conventional risk assessment p 311 A90-49065 for energetic ion exposure Astronaut exposure to space radiation - Space Shuttle experience
- [SAE PAPER 901342] p 313 A90-49377 Effects of protracted ionizing radiation dosage on humans and animals: A brief review of selected investigations

p 309 N90-27241

- [AD-A222240]
- Mechanisms of microwave induced damage in biologic materials (AD-A222454) p 309 N90-27242
- **BADIATION EFFECTS**
- Radiation-induced polymerization in dilute aqueous solutions of cyanides p 305 A90-46655 Accurate determination of the complex permittivity of biological tissue at 90 GHz, 70 GHz, and over a broad band around 35 GHz
- [AD-A222062] p 309 N90-27240 Effects of ionizing radiation on the performance of selected tactical combat crews
- [AD-A222880] p 315 N90-27248 RADIATION HAZARDS
- Nuclear reaction effects in conventional risk assessment for energetic ion exposure p 311 A90-49065 Risk assessment methodologies for target fragments produced in high-energy nucleon reactions
  - p 312 A90-49066 Recent developments in estimates of cancer risk from
- ionizing radiation [SAE PAPER 901344] p 313 A90-49379
- **BADIATION INJURIES** Effects of protracted ionizing radiation dosage on humans and animals: A brief review of selected investigations
- [AD-A222240] p 309 N90-27241 RADIATION MEASUREMENT LifeSat - Radiation research
- [SAE PAPER 901228] p 307 A90-49300 Deep-space radiation exposure analysis for solar cycle XXI (1975-1986)
- [SAE PAPER 901347] p 314 A90-49381 RADIATION PROTECTION
- Astronaut exposure to space radiation Space Shuttle experience
- ISAE PAPER 9013421 p 313 A90-49377 **RADIATION SHIELDING**
- Deep-space radiation exposure analysis for solar cycle XXI (1975-1986) p 314 A90-49381
- [SAE PAPER 901347] **BADIATION SICKNESS**
- Anti-LPS antibodies reduce endotoxemia in whole body Co-60 irradiated primates - A preliminary report p 306 A90-48584
- Effects of ionizing radiation on the performance of selected tactical combat crews
- [AD-A222880] p 315 N90-27248 RADIATION THERAPY

Effects of protracted ionizing radiation dosage on humans and animals: A brief review of selected investigations

- [AD-A222240] o 309 N90-27241 RADIATION TOLERANCE
- Superhelicity and DNA radiation sensitivity [SAE PAPER 901349] p 308 p 308 A90-49383 RADIATIVE HEAT TRANSFER
- Miniaturization study of heat exhausting radiator of lunar hase
- [SAE PAPER 901206] p 322 A90-49281 RADIOBIOLOGY
- Nuclear reaction effects in conventional risk assessment for energetic ion exposure p 311 A90-49065 LifeSat - Radiation research
- [SAE PAPER 901228] p 307 A90-49300 Effects of ionizing radiation on the performance of selected tactical combat crews
- [AD-A222880] p 315 N90-27248 RAPID EYE MOVEMENT STATE
- Evoked potentials during periods of look fixation and periods of saccadic eye movement in humans p 309 A90-46520
- **REACTION KINETICS** 
  - Chemical activity of simple basic peptides p 339 A90-48096
- Energy-rich glyceric acid oxygen esters Implications for the origin of glycolysis p 339 A90-48097

The case for the chemoautotrophic origin of life in an iron-sulfur world p 339 A90-48099 REACTION TIME

SUBJECT INDEX

- Categorization and identification of simultaneous targets
- [IZF-1989-22] p 338 N90-28337 REAL TIME OPERATION
- Real-time measurement of mental workload using psychophysiological measures
- [AD-A221462] p 319 N90-27258 A real-time optical 6D tracker for head-mounted display systems
- 1 AD-A2228841 p 334 N90-27262 RECYCLING
- Human subjects concerns in ground based ECLSS testing - Managing uncertainty in closely recycled
- systems [SAE PAPER 901251] p 325 A90-49320 REDUCED GRAVITY
- Plant biology research on 'LifeSat' [SAE PAPER 901227]
  - p 307 A90-49299 Research centrifuge accommodations on Space Station Freedom
- [SAE PAPER 901304] p 308 A90-49356 Scientific uses and technical implementation of a variable gravity centrifuge on Space Station Freedom
- [SAE PAPER 901360] p 330 A90-49393 Robot dynamics in reduced gravity environment p 336 N90-27333
- REDUNDANCY
- Resolution of seven-axis manipulator redundancy: p 336 N90-27331 heuristic issue REENTRY VEHICLES
- Medical concerns for Assured Crew Return Vehicle from Snace Station Freedom
- [SAE PAPER 901326] p 313 A90-49366 REFLEXES
- Earth horizontal axis rotational responses in patients with milateral peripheral vestibular defi

				p 318	A90-49069
REFRIGERATORS					
Development	of	the	Space	Station	Freedom
Refrigerator/Free	zer	and Fr	reezer		
(SAF PAPER 901	1300	1		n 328	400 40352

- RELIABILITY
- AX-5 space suit reliability model [SAE PAPER 901361] p 330 A90-49394 REMOTE CONTROL
- Creature co-op: Achieving robust remote operations with a community of low-cost robots p 336 N90-27303 RETENTION (PSYCHOLOGY)

skills: Application to training

Space Station Freedom [SAE PAPER 901326]

RHYTHM (BIOLOGY)

[AD-A221972]

(FTN-90-97453) RIBONUCLEIC ACIDS

**RIGID STRUCTURES** 

ionizing radiation

ROBOT ARMS

robot

RISK

[AIAA PAPER 90-3399]

(SAE PAPER 901344)

AIAA PAPER 90-3431]

[AIAA PAPER 90-3432]

skills: Acquisition, transfer, and retention

[AD-A221709]

[AD-A221744]

RETINA

Automatic information processing and high performance

Automatic information processing and high performance

Intraocular pressure, retinal vascular, and visual acuity

Medical concerns for Assured Crew Return Vehicle from

The 1989 Gordon Research Conference on Chronobiology

Electrocardiogram of military aircraft pilots measured during real flight missions: Study of the variability of the

Did membrane electrochemistry precede translation?

Chemical structure of a prebiotic analog of adenosine

Template-directed oligomerization of 5-prime-deoxy

A preliminary study on experimental simulation of

Recent developments in estimates of cancer risk from

The intrinsic approach to space robotic manipulators

Capture control for manipulator arm of free-flying space

Robot dynamics in reduced gravity environment

5-nucleosideacetic acid derivatives p 339 A90-48098

cardiac rhythm in correlation with working stress

dynamics of space manipulator system

changes during 48 hours of 10-deg head-down tilt

P 310 A90-48586 RETURN TO EARTH SPACE FLIGHT

p 319 N90-27259

p 319 N90-27260

p 313 A90-49366

p 309 N90-28322

p 316 N90-28324

p 305 A90-46652

p 305 A90-46654

p 321 A90-47654

p 313 A90-49379

p 321 A90-47684

p 321 A90-47685

p 336 N90-27333

#### SUBJECT INDEX

#### ROBOT DYNAMICS

- The kinematics and dynamics of space manipulators -The virtual manipulator approach p 320 A90-46399 On dynamics and control of multi-link flexible space manipulators
- [AIAA PAPER 90-3396] p 320 A90-47651 Dynamics and positioning control of space robot with flexible manipulators
- [AIAA PAPER 90-3397] p 320 A90-47652 -Model-based iterative learning control of Space-Shuttle manipulator
- [AIAA PAPER 90-3398] p 320 A90-47653 A preliminary study on experimental simulation of
- dynamics of space manipulator system [AIAA PAPER 90-3399] p 321 A90-47654 The intrinsic approach to space robotic manipulators
- [AIAA PAPER 90-3431] p 321 A90-47684 Capture control for manipulator arm of free-flying space robot
- [AIAA PAPER 90-3432]
   p 321
   A90-47685

   Resolution of seven-axis manipulator redundancy: A heuristic issue
   p 336
   N90-27331
- Robot dynamics in reduced gravity environment p 336 N90-27333

#### ROBOTICS

- Three-dimensional camera space manipulation
- p 320 A90-46400 The intrinsic approach to space robotic manipulators [AIAA PAPER 90-3431] p 321 A90-47684 Agent independent task planning p 335 N90-27276 Simulation-based intelligent robotic agent for Space Station Freedom p 335 N90-27298 A vision-based telerobotic control station
- p 336 N90-27311 Robot dynamics in reduced gravity environment p 336 N90-27333
- ROBOTS
- Creature co-op: Achieving robust remote operations with a community of low-cost robots p 336 N90-27303 ROTATION
- Eyes open versus eyes closed Effect on human rotational responses p 318 A90-49070 Rotationally actuated prosthetic helping hand
- [NASA-CASE-MFS-28426-1] p 334 N90-27261

# S

#### SACCADIC EYE MOVEMENTS

Evoked potentials during periods of look fixation and periods of saccadic eye movement in humans p 309 A90-46520

SAFETY

- Human factors and safety considerations of night vision systems flight [USAARL-89-12] p 337 N90-28332
- [USAARL-89-12] p 337 N90-28332 SATELLITE ATTITUDE CONTROL
- Trajectory planning for a space manipulator [AAS PAPER 89-440] p 320 A90-46827 SCANNING
- Cockpit Ocular Recording System (CORS) [NASA-CR-4281] p 314 N90-27244 SEATS

Partial supination versus Gz protection

- p 311 A90-48592 SELF ORGANIZING SYSTEMS
- Conference on The Perception of Structure Program and Abstracts (AD-A2224371 n 319 N90-28328
- [AD-A222437] p 319 N90-28328 SENSORY STIMULATION
- Non-linear analysis of visual cortical neurons (AD-A221543) p 315 N90-27250 SEROTONIN
- The influence of serotonine and histamine, introduced in small doses, on body temperature
- p 306 A90-48200 SEX FACTOR Physiological reactions to heat stress; quantifying the effects of individual parameters
- [IZF-1989-30] p 316 N90-28326 SHAPES Curvature estimation in orientation selection
- [AD-A221481] p 315 N90-27249 SHOCK TUBES
- The effects of blast trauma (impulse noise) on hearing: A parametric study source 2
- [AD-A221731] p 316 N90-27253 SHOCK WAVES
- The effects of blast trauma (impulse noise) on hearing: A parametric study source 2
- [AD-A221731] p 316 N90-27253 SIGNAL DETECTION The effects of luminance boundaries on color
- perception [AD-A221544] p 315 N90-27251

- SIGNAL TO NOISE RATIOS
- A network model of catecholamine effects Gain, signal-to-noise ratio, and behavior p 317 A90-47247 SIGNS AND SYMPTOMS
- Space Station Freedom viewed as a 'tight building' [SAE PAPER 901382] p 331 A90-49410 SINGULARITY (MATHEMATICS)
- Resolution of seven-axis manipulator redundancy: A heuristic issue p 336 N90-27331 SOFTWARE TOOLS
- A prototype computer-aided modelling tool for life-support system models [SAE PAPER 901269] p 327 A90-49337
- [SAE PAPER 901269] p 327 A90-49337 SOLAR FLARES
- Deep-space radiation exposure analysis for solar cycle XXI (1975-1986)
- [SAE PAPER 901347] p 314 A90-49381 SPACE EXPLORATION
- Crew selection, productivity and well-being for human exploration missions
- [SAE PAPER 901362] p 318 A90-49395 A methodology for choosing candidate materials for the fabrication of planetary space suit structures
- [SAE PAPER 901429] p 333 A90-49430 SPACE FLIGHT STRESS
- Changes in geometrical and biomechanical properties of immature male and female rat tibia p 306 A90-48587
- SPACE HABITATS
- Designing space habitats for human productivity [SAE PAPER 901204] p 322 A90-49279
- Human requirements for quality life in lunar base [SAE PAPER 901207] p 322 A90-49282 Biosphere 2 project status - Design of a closed manned
- terrestrial ecological system [SAE PAPER 901233] p 324 A90-49303
- Low-temperature thermal control for a lunar base [SAE PAPER 901242] p 324 A90-49312 Life support - Thoughts on the design of safety
- systems (SAE PAPER 901248) p 325 A90-49318
- Pumping equipment of autonomous inhabited systems [SAE PAPER 901250] p 325 A90-49319 Constraints and rationale for Space Station Freedom
- Habitation and laboratory module topology [SAE PAPER 901297] p 327 A90-49350
- Critical technologies Spacecraft habitability [SAE PAPER 901384] p 331 A90-49412 Habitability studies for Hermes - A status of simulation
- and validation [SAE PAPER 901388] p 332 A90-49416
- Common approach for planetary habitation systems implementation [SAE PAPER 901417] p.332 A90-49425
- [SAE PAPER 901417] p 332 A90-49425 SPACE LABORATORIES Integrated air/water cooling concepts for space
- [SAE PAPER 901370] p 330 A90-49400
- SPACE PERCEPTION Non-linear analysis of visual cortical neurons
- [AD-A221543] p 315 N90-27250 A real-time optical 6D tracker for head-mounted display systems
- [AD-A222884] p 334 N90-27262 SPACE PSYCHOLOGY
- Human requirements for quality life in lunar base [SAE PAPER 901207] p 322 A90-49282 SPACE SHUTTLE MISSION 51-J
- Recent experiences with iodine water disinfection in Shuttle
- [SAE PAPER 901356] p 329 A90-49389 SPACE SHUTTLE MISSION 61-A
- Recent experiences with iodine water disinfection in Shuttle
- [SAE PAPER 901356] p 329 A90-49389 SPACE SHUTTLE MISSIONS
- Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations
- [SAE PAPER 901357] p 330 A90-49390 SPACE SHUTTLE ORBITERS
- A model for a space shuttle safing and failure-detection expert p 336 N90-27314 SPACE SHUTTLES
- Model-based iterative learning control of Space-Shuttle manipulator
- (AIAA PAPER 90-3398) p 320 A90-47653 Medical concerns for Assured Crew Return Vehicle from Space Station Freedom
- [SAE PAPER 901326] p 313 A90-49366 Application of the pentaiodide strong base resin disinfectant to the U.S. space program
- [SAE PAPER 901380]
   p 331
   A90-49408

   A model for a space shuttle safing and failure-detection
   expert
   p 336
   N90-27314

SPACE STATION PAYLOADS

Constraints and rationale for Space Station Freedom Habitation and laboratory module topology [SAE PAPER 901297] p 327 A90-49350

SPACE STATIONS

- SPACE STATIONS

   Work/control stations in Space Station weightlessness

   [SAE PAPER 901203]
   p 322

   A90-49278
- [SAE PAPER 901203] p 322 A90-49278 Past and present environmental control and life support systems on manned spacecraft
- [SAE PAPER 901210] p 323 A90-49285 Optimal configuration and operation for the Space Shuttle Freedom ECLSS
- [SAE PAPER 901212] p 323 A90-49287
- System level water balance for Space Station Freedom [SAE PAPER 901213] p 323 A90-49288
- Water recovery and management test support modeling for Space Station Freedom
- [SAE PAPER 901214] p 323 A90-49289 Phase III Simplified Integrated Test (SIT) results - Space Station ECLSS testing
- [SAE PAPER 901252] p 325 A90-49321
- Test bed design for evaluating the Space Station ECLSS Water Recovery System [SAE PAPER 901253] p 325 A90-49322
- Facility for generating crew waste water product for ECLSS testing [SAE PAPER 901254] p 325 A90-49323
- [SAE PAPER 901254] p 325 A90-49323 Liquid Chromatography/Mass Spectrometry - A new
- technique for water recovery system testing [SAE PAPER 901255] p 326 A90-49324 Operational ninety-day manned test of regenerative life
- support systems [SAE PAPER 901257] p 326 A90-49326
- Space Station Freedom CHeCS overview --- Crew Health Care System [SAE PAPER 901258] p 312 A90-49327
- [SAE PAPER 901258] p 312 A90-49327 Space Station requirements for in-flight exercise countermeasures
- [SAE PAPER 901259] p 312 A90-49328 Development of the Space Station Freedom
- Environmental Health System [SAE PAPER 901260] p 312 A90-49329 Microbiology facilities aboard Space Station Freedom

Application of a comprehensive G189A ECLSS model

Design definition of the Space Station Freedom Galley

Space Station Crew Quarters and Personal Hygiene

Space Station Freedom science support equipment

Facilities for animal research in space with special

Research centrifuge accommodations on Space Station

Design and evaluation of an electronic stethoscope

Sterile water for injection system for on-site production

Formulation, preparation and delivery of parenteral fluids

Medical concerns for Assured Crew Return Vehicle from

Medical information BUS - Integrated monitoring for the

Space Station Environmental Health System water

A volatile organics concentrator for use in monitoring

Detection of gas loading of the water onboard Space

Scientific uses and technical implementation of a

variable gravity centrifuge on Space Station Freedom

for the Space Station Freedom Health Maintenance

and Wardroom subsystems and their effect on Space

in assessing specific Space Station conditions

p 308 A90-49330

p 326 A90-49333

327 A90-49351

Station Freedom

p 328 A90-49352

p 328 A90-49353

p 328 A90-49354

p 308 A90-49355

p 308 A90-49356

p 313 A90-49363

p 313 A90-49364

p 313 A90-49365

p 313 A90-49366

p 313 A90-49367

p 329 A90-49384

p 329 A90-49385

p 329 A90-49386

p 330 A90-49393

A-11

(SSE)

Facility

Freedom

Facility

[SAE PAPER 901262]

[SAE PAPER 901265]

[SAE PAPER 901299]

[SAE PAPER 901300]

[SAE PAPER 901301]

[SAE PAPER 901302]

[SAE PAPER 901303]

[SAE PAPER 901304]

[SAE PAPER 901324]

[SAE PAPER 901325]

Space Station Freedom

HMF of Space Station Freedom

[SAE PAPER 901326]

(SAE PAPER 901328)

[SAE PAPER 901351]

[SAE PAPER 901352]

[SAE PAPER 901353]

[SAE PAPER 901360]

Space Station water quality

quality monitoring

Station Freedom

Station Environmental Systems

Development of the Space Refrigerator/Freezer and Freezer

reference to Space Station Freedom

system for the Space Station Freedom HMF [SAE PAPER 901323] p 313

of IV fluids at Space Station Freedom HMF

#### SPACE SUITS

Survival of pathogenic bacteria under nutrient starvation conditions --- aboard orbiting space stations p 308 A90-49409

- [SAE PAPER 901381] Space Station Freedom viewed as a 'tight building [SAE PAPER 901382] p 331 A90-49410
- Identifying atmospheric monitoring needs for Space Station Freedom [SAE PAPER 901383] p 331 A90-49411
- Hygiene and water in Space Station p 331 A90-49414 (SAE PAPER 901386)
- European Space Station health care system concept p 332 A90-49415 [SAE PAPER 901387] Space Station Freedom contamination requirements and
- predictions p 332 A90-49418 [SAE PAPER 901408]
- Habemsi study A study on human factors for space station design [SAE PAPER 901416] p 332 A90-49424
- A direct-interface fusible heat sink for astronaut cooling
- p 333 A90-49434 [SAE PAPER 901433] Agent independent task planning p 335 N90-27276 SPACE SUITS
- Development of the suit enclosure of the European EVA space suit
- [SAE PAPER 901244] p 324 A90-49314 EVA life support design advancements [SAE PAPER 901245] p 3.
- p 324 A90-49315 Emulation of the Eva Soviet suit for neutral buoyancy simulations [SAE PAPER 901246] p 324 A90-49316
- Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations
- [SAE PAPER 901357] p 330 A90-49390 AX-5 space suit reliability model [SAE PAPER 901361] p 330 A90-49394
- Design considerations for future planetary space suits p 333 [SAE PAPER 901428] A90-49429 A methodology for choosing candidate materials for the
- fabrication of planetary space suit structures [SAE PAPER 901429] p 333 A90-49430
- An air bearing fan for EVA suit ventilation [SAE PAPER 901432] A90-49433 p 333
- SPACE TOOLS The kinematics and dynamics of space manipulators The virtual manipulator approach
- p 320 A90-46399 Trajectory planning for a space manipulator p 320 A90-46827 [AAS PAPER 89-440]
- On dynamics and control of multi-link flexible space manipulators [AIAA PAPER 90-3396] p 320 A90-47651
- A preliminary study on experimental simulation of dynamics of space manipulator system
- [AIAA PAPER 90-3399] p 321 A90-47654 The intrinsic approach to space robotic manipulators [AIAA PAPER 90-3431] p 321 A90-47684
- Capture control for manipulator arm of free-flying space rohot
- (AIAA PAPER 90-3432) p 321 A90-47685 Smart end effector for dexterous manipulation in

[AIAA PAPER 90-3434] p 321 A90-47687 SPACEBORNE EXPERIMENTS

- Plant biology research on 'LifeSat' p 307 A90-49299 [SAE PAPER 901227] Facilities for animal research in space with special
- reference to Space Station Freedom p 308 A90-49355 [SAE PAPER 901303] SPACECRAFT CABIN ATMOSPHERES
- Status of JEM ECLSS design
- [SAE PAPER 901209] p 322 A90-49284 Atmosphere trace gas contamination management for the COLUMBUS pressurized modules
- [SAE PAPER 901288] p 327 A90-49348 Space Station Freedom science support equipment [SAE PAPER 901302] p 328 A90-49354
- SPACECRAFT CABINS IVA and EVA work place design for a man-tended ,
- system [SAE PAPER 901415] p 332 A90-49423
- Spacecraft accommodation strategies for manned Mars missions
- [SAE PAPER 901418] p 333 A90-49426 SPACECRAFT CONFIGURATIONS
- Space Station Freedom contamination requirements and predictions
- [SAE PAPER 901408] p 332 A90-49418 SPACECRAFT CONTAMINATION
- Atmosphere trace gas contamination management for the COLUMBUS pressurized modules [SAE PAPER 901288] p 327 A90-49348
- Application of the pentaiodide strong base resin disinfectant to the U.S. space program
- p 331 A90-49408 [SAE PAPER 901380]

A-12

- Space Station Freedom contamination requirements and predictions [SAE PAPER 901408] p 332 A90-49418
- SPACECRAFT CONTROL
- Model-based iterative learning control of Space-Shuttle manipulator
- p 320 A90-47653 [AIAA PAPER 90-3398] SPACECRAFT DESIGN
- Designing space habitats for human productivity p 322 A90-49279 [SAE PAPER 901204] Space Station Freedom Environmental Control and Life
- Support System design A status report SAE PAPER 901211 p 323 A90-49286 Design definition of the Space Station Freedom Galley and Wardroom subsystems and their effect on Space
- Station Environmental Systems [SAE PAPER 901299] p 327 A90-49351
- Habernsi study A study on human factors for space station design [SAE PAPER 901416] p 332 A90-49424
- SPACECRAFT DOCKING
- Manual control aspects of Space Station docking maneuvers [SAE PAPER 901202] p 321 A90-49277
- SPACECRAFT ENVIRONMENTS
- Space Station Freedom Environmental Control and Life Support System design - A status report
- p 323 A90-49286 [SAE PAPER 901211] Pumping equipment of autonomous inhabited systems [SAE PAPER 901250] p 325 A90-49319 Station Freedom
- Development of the Sp Environmental Health System Space [SAE PAPER 901260] p 312 A90-49329
- Microbiology facilities aboard Space Station Freedom (SSE)
- [SAE PAPER 901262] p 308 A90-49330 Space Station Environmental Health System water quality monitoring
- (SAE PAPER 901351) p 329 A90-49384 Detection of gas loading of the water onboard Space Station Freedom
- [SAE PAPER 901353] p 329 A90-49386
- New total organic carbon analyzer [SAE PAPER 901354] p 329 A90-49387 Influence of iodine on the treatment of spacecraft
- humidity condensate to produce potable water [SAE PAPER 901355] p 329 p 329 A90-49388
- Identifying atmospheric monitoring needs for Space Station Freedom
- [SAE PAPER 901383] p 331 A90-49411 Hygiene and water in Space Station
- (SAE PAPER 901386) p 331 A90-49414 Habitability studies for Hermes - A status of simulation
- and validation [SAE PAPER 901388] p 332 A90-49416
- SPACECRAFT EQUIPMENT Development of the Space Station Freedom
- Betrigerator/Freezer and Freezer [SAE PAPER 901300] p 328 A90-49352
- SPACECRAFT LAUNCHING
- Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations
- [SAE PAPER 901357] p 330 A90-49390 SPACECRAFT MANEUVERS
- Manual control aspects of Space Station docking maneuvers
- [SAE PAPER 901202] p 321 A90-49277 SPACECRAFT MODULES
- Atmosphere trace gas contamination management for the COLUMBUS pressurized modules
- p 327 A90-49348 [SAE PAPER 901288] Constraints and rationale for Space Station Freedom Habitation and laboratory module topology
- [SAE PAPER 901297] p 327 A90-49350 Integrated air/water cooling concepts for space
- laboratory modules [SAE PAPER 901370] p 330 A90-49400
- SPACECRAFT MOTION Trajectory planning for a space manipulator
- [AAS PAPER 89-440] p 320 A90-46827 SPACECRAFT RADIATORS
- Miniaturization study of heat exhausting radiator of lunar base p 322 A90-49281
- [SAE PAPER 901206] SPACECRAFT SHIELDING
- Astronaut exposure to space radiation Space Shuttle experience
- [SAE PAPER 901342] p 313 A90-49377 SPACECREWS
- Operational ninety-day manned test of regenerative life upport systems
- [SAE PAPER 901257] p 326 A90-49326 Development of the Space Environmental Health System Station Freedom [SAE PAPER 901260] p 312 A90-49329

Medical concerns for Assured Crew Return Vehicle from Space Station Freedom (SAE PAPER 901326) p 313 A90-49366

- Crew selection, productivity and well-being for human exploration missions
- [SAE PAPER 901362] p 318 A90-49395 Hermes-crew integration aspects [SAE PAPER 901390] . p 332 A90-49417
- SPATIAL DISTRIBUTION
- Curvature estimation in orientation selection
- (AD-A221481) p 315 N90-27249 STABILITY

The dynamics of orbital maneuvering: Design and evaluation of a visual display aid for human controllers p 336 N90-27767

#### STAPHYLOCOCCUS

SULFUR COMPOUNDS

SUPERCRITICAL FLUIDS

[SAE PAPER 901333]

[SAE PAPER 901381]

[NASA-TM-102799]

[SAE PAPER 901380]

SYSTEMS ENGINEERING

[SAE PAPER 901248]

Water Recovery System

modeling and trade studies

[SAE PAPER 901253]

ISAE PAPER 9012641

[SAE PAPER 901267]

TARGET ACQUISITION

[AIAA PAPER 90-3434]

isual channels under stress

TARGET RECOGNITION

snace

TASKS

performance

[AD-A222686]

SYNTHETIC RESINS

SYSTEMS ANALYSIS

systems

waste in supercritical water

[NASA-CASE-MFS-28426-1]

Partial supination versus Gz protection

conditions --- aboard orbiting space stations

streams in a typical crewed space habitat

disinfectant to the U.S. space program

The virtual manipulator approach

Rotationally actuated prosthetic helping hand

iron-sulfur world

SUPINE POSITION

SUPPORTS

SURVIVAL

SWEAT

Survival of pathogenic bacteria under nutrient starvation conditions --- aboard orbiting space stations [SAE PAPER 901381] p 308 A90-49409 STERILIZATION

- Sterile water for injection system for on-site production of IV fluids at Space Station Freedom HMF [SAE PAPER 901324]
- p 313 A90-49364 STETHOSCOPES
- Design and evaluation of an electronic stethoscope system for the Space Station Freedom HMF **ISAE PAPER 9013231** p 313 A90-49363
- STRESS (PHYSIOLOGY)
- Stress-induced deficits of the human immune system p 310 A90-48331
- The integration of complex information from auditory and visual channels under stress
- (AD-A222686) p 314 N90-27245 STRUCTURAL DESIGN

evaluation of a visual display aid for human controllers

The dynamics of orbital maneuvering: Design and

The case for the chemoautotrophic origin of life in an

Oxidation kinetics of model compounds of metabolic

Survival of pathogenic bacteria under nutrient starvation

Generation rates and chemical compositions of waste

Application of the pentaiodide strong base resin

The kinematics and dynamics of space manipulators

Life support - Thoughts on the design of safety

Test bed design for evaluating the Space Station ECLSS

LSOPP II - A program for advanced EVA system

Computer aided system engineering and analysis

(CASE/A) modeling package for ECLS systems - An

Т

Smart end effector for dexterous manipulation in

Visual mechanisms and predictors of far field visual task

The integration of complex information from auditory and

p 336 N90-27767

p 339 A90-48099

p 328 A90-49371

p 311 A90-48592

p 334 N90-27261

p 308 A90-49409

p 337 N90-28333

p 331 A90-49408

p 320 A90-46399

p 325 A90-49318

p 325 A90-49322

p 326 A90-49332

p 327 A90-49336

p 321 A90-47687

p 311 A90-48700

p 314 N90-27245

# SUBJECT INDEX

#### TELEOPERATORS

Robot dynamics in reduced gravity environment p 336 N90-27333

TEMPERATURE CONTROL

- Low-temperature thermal control for a lunar base [SAE PAPER 901242] p 324 A90-49312 Active thermal control systems for lunar and Martian exploration
- [SAE PAPER 901243] p 324 A90-49313 Application of a comprehensive G189A ECLSS model in assessing specific Space Station conditions
- ISAE PAPER 9012651 p 326 A90-49333 Integrated model of G189A and Aspen-plus for the transient modeling of extravehicular activity atmospheric control systems
- [SAE PAPER 901268] p 326 A90-49335 Computer aided system engineering and analysis (CASE/A) modeling package for ECLS systems - An overview
- [SAE PAPER 901267] p 327 A90-49336 Design definition of the Space Station Freedom Galley and Wardroom subsystems and their effect on Space Station Environmental Systems
- [SAE PAPER 901299] p 327 A90-49351 Advanced air revitalization system modeling and testing
- [SAE PAPER 901332] p 328 A90-49370 Integrated air/water cooling concepts for space laboratory modules
- [SAE PAPER 901370] p 330 A90-49400 TEST EQUIPMENT
- Smart end effector for dexterous manipulation in space
- [AIAA PAPER 90-3434] p 321 A90-47687 TEST FACILITIES
- Test bed design for evaluating the Space Station ECLSS Water Recovery System
- [SAE PAPER 901253] p 325 A90-49322 TEST STANDS
- Engineering testbed for biological water/air reclamation and recycling [SAE PAPER 901231] p 324 A90-49302
- THERMAL DECOMPOSITION
- Toxicological aspects of fire onboard aircrafts: Role of the pressurization and ventilation in the cockpit p 337 N90-28335 [ETN-90-974521
- THERMAL ENVIRONMENTS Development of the Space Station Freedom Refrigerator/Freezer and Freezer
- [SAE PAPER 901300] p 328 A90-49352 THERMAL INSULATION
- Physical characteristics of clothing materials with regard to heat transport
- p 337 N90-28336 [JZF.1989.10] THERMAL MAPPING
- Human factors and safety considerations of night vision systems flight using thermal imaging systems [AD-A223226] p 334 N90-27263
- THERMODYNAMIC PROPERTIES Calculation of clothing insulation and vapour resistance
- [IZE-1989-49] p 338 N90-28338 THERMOREGULATION
- Participation of cerebral noradrenergic structures in thermoregulation during the adaptation to cold
- p 306 A90-48199 The influence of serotonine and histamine, introduced in small doses, on body temperature
- p 306 A90-48200 Work enhancement and thermal changes during intermittent work in cool water after carbohydrate loading
- AD-A2228771 p 315 N90-27247 THREE DIMENSIONAL MODELS
- 3-D components of a biological neural network visualized in computer generated imagery. II - Macular neural network p 307 A90-49049 organization
- TIBIA Changes in geometrical and biomechanical properties of immature male and female rat tibia
- p 306 A90-48587 TISSUES (BIOLOGY)
- The chronic effect of an electrostatic field on certain biochemical indices of tissues p 305 A90-46524 Accurate determination of the complex permittivity of biological tissue at 90 GHz, 70 GHz, and over a broad band around 35 GHz
- AD-A2220621 p 309 N90-27240 TOLERANCES (PHYSIOLOGY)
- Mechanisms of microwave induced damage in biologic materials [AD-A222454] p 309 N90-27242
- TOPOLOGY Constraints and rationale for Space Station Freedom
- Constraints and fationale for opcion
   Constraints and fationale for opcion

   Habitation and laboratory module topology
   ISAF PAPER 901297]
   p 327
   A90-49350

#### TOXICITY

- Toxicological aspects of fire onboard aircrafts: Role of the pressurization and ventilation in the cockpit
- [ETN-90-97452] TRACE CONTAMINANTS p 337 N90-28335
- ECLS technology development programme Results and further activities [SAE PAPER 901289] p 327 A90-49349
- Advanced air revitalization system modeling and testing [SAE PAPER 901332]
- p 328 A90-49370 Generation rates and chemical compositions of waste streams in a typical crewed space habitat
- [NASA-TM-102799] p 337 N90-28333 TRACE ELEMENTS
- Atmosphere trace gas contamination management for the COLUMBUS pressurized modules
- [SAE PAPER 901288] p 327 A90-49348 TRACKING (POSITION)
- Tracking a head-mounted display in a room-sized environment with head-mounted cameras p 335 N90-27266 [AD-A2225451
- TRAINING ANALYSIS
- The effects of training on errors of perceived direction in perspective displays [NASA-TM-102792] p 319 N90-28329
- TRAINING EVALUATION
- Human factors research in aircrew performance and training p 335 N90-27267
- [AD-A221657]
- TRAJECTORY ANALYSIS
- Trajectory planning for a space manipulator [AAS PAPER 89-440] p 320 p 320 A90-46827 TRAJECTORY CONTROL
- The dynamics of orbital maneuvering: Design and evaluation of a visual display aid for human controllers p 336 N90-27767
- TRANSFER OF TRAINING
- Automatic information processing and high performance skills: Application to training [AD-A221709] p 319 N90-27259
  - Automatic information processing and high performance
- skills: Acquisition, transfer, and retention p 319 N90-27260 [AD-A221744]

# U

#### U.S.S.R. SPACE PROGRAM

- Emulation of the Eva Soviet suit for neutral buoyancy simulations
- [SAE PAPER 901246] p 324 A90-49316 UNCONSCIOUSNESS
- Positive pressure breathing for acceleration protection and its role in prevention of inflight G-induced loss of p 311 A90-48591 consciousness
- UNMANNED SPACECRAFT
- Plant biology research on 'LifeSat' [SAE PAPER 901227] p 307 A90-49299 URINE
- Generation rates and chemical compositions of waste streams in a typical crewed space habitat p 337 N90-28333 [NASA-TM-102799]

#### ν

#### VASOCONSTRICTOR DRUGS

- The influence of serotonine and histamine, introduced in small doses, on body temperature
- p 306 A90-48200 VENTILATION
- Toxicological aspects of fire onboard aircrafts: Role of the pressurization and ventilation in the cockpit [ETN-90-97452] p 337 N90-28335

#### VENTILATION FANS

- ECLS technology development programme Results and further activities
- [SAE PAPER 901289] p 327 A90-49349 An air bearing fan for EVA suit ventilation
- [SAE PAPER 901432] p 333 A90-49433 VERTICAL PERCEPTION
- Influence of gravity on cat vertical vestibulo-ocular p 307 A90-49053 reflex

#### VESTIBULAR NYSTAGMUS

- Nystagmus responses in a group of normal humans during earth-horizontal axis rotation p 317 A90-49046 The Chinchilla's vestibulo-ocular reflex
- p 307 A90-49047 Visual-vestibular interaction in humans during earth-horizontal axis rotation p 317 A90-49048 Influence of gravito-inertial force on vestibular nystagmus in man

p 316 N90-28325

[[ZE-1989-24]]

#### VESTIBUI AR TESTS

- Nystagmus responses in a group of normal humans during earth-horizontal axis rotation p 317 A90-49046 The Chinchilla's vestibulo-ocular reflex
  - p 307 A90-49047

WASTE WATER

- Influence of gravity on cat vertical vestibulo-ocular reflex p 307 A90-49053
- Earth horizontal axis rotational responses in patients with unilateral peripheral vestibular deficits p 318 A90-49069
  - Eyes open versus eyes closed Effect on human rotational responses p 318 A90-49070
- VIBRATION EFFECTS
  - Criteria for a recommended standard: Occupational exposure to hand-arm vibration [PB90-168048] p 337 N90-28331
  - VISION
  - The integration of complex information from auditory and visual channels under stress [AD-A222686] p 314 N90-27245
  - Curvature estimation in orientation selection [AD-A221481] p 315 N90-27249
- VISUAL ACUITY

performance

[AD-A221543]

[AD-A221544]

presence of glare

[PB90-155987]

targets [IZF-1989-22]

VISUAL STIMULI

[JZF-1989-22]

monkeys (Macaca mulatta)

VISUAL TASKS

targets

VOMITING

sickness

WASTE DISPOSAL

Shuttle Freedom ECLSS

[SAE-PAPER 901212]

Assembly for HERMES

Water recycling in space [SAE PAPER 901247]

ISAE PAPER 9012541

[SAE PAPER 901287]

[NASA-TM-1027991

WASTE TREATMENT

WASTE WATER

FCLSS testing

perception

plaid

VISUAL PERCEPTION

- Intraocular pressure, retinal vascular, and visual acuity changes during 48 hours of 10-deg head-down tilt
- p 310 A90-48586 Human factors and safety considerations of night vision
- systems flight using thermal imaging systems [AD-A223226] p 334 N90-27263 VISUAL DISCRIMINATION
- The integrated area measure of visual endogenous ERPs: Relation to cognitive workload and hemisphere (AD-A2231911 p 318 N90-27255 VISUAL FIELDS
- Cockpit Ocular Recording System (CORS) p 314 N90-27244 [NASA-CR-4281] VISUAL OBSERVATION

Visual mechanisms and predictors of far field visual task

Evoked potentials during periods of look fixation and

Effect of contrast on the perceived direction of a moving

The effects of luminance boundaries on color

The measurement of dark adaptation level in the

Categorization and identification of simultaneous

Categorization and identification of simultaneous

Effects of competition on video-task performance in

The susceptibility of rhesus monkeys to motion

RU 24969-induced emesis in the cat - 5-HT1 sites other

W

Optimal configuration and operation for the Space

Generation rates and chemical compositions of waste

The development of the Human Waste Collection

Generation rates and chemical compositions of waste

Facility for generating crew waste water product for

than 5-HT1A, 5-HT1B or 5-HT1C implicated

streams in a typical crewed space habitat

streams in a typical crewed space habitat [NASA-TM-102799] p 33

periods of saccadic eve movement in humans

Non-linear analysis of visual cortical neurons

p 311 A90-48700

p 309 A90-46520

p 317 A90-49062

p 315 N90-27250

p 315 N90-27251

p 316 N90-28323

p 338 N90-28337

p 338 N90-28337

p 317 A90-49039

p 306 A90-48585

p 307 A90-49041

p 323 A90-49287

p 337 N90-28333

p 327 A90-49347

p 337 N90-28333

p 325 A90-49317

p 325 A90-49323

A-13

## SUBJECT INDEX

## WATER

#### WATER

Sterile water for injection system for on-site production of IV fluids at Space Station Freedom HMF [SAE PAPER 901324] p 313 A90-49364

- Oxidation kinetics of model compounds of metabolic waste in supercritical water [SAE PAPER 901333]
- p 328 A90-49371 WATER BALANCE
- System level water balance for Space Station Freedom p 323 A90-49288
- [SAE PAPER 901213] WATER CONSUMPTION System level water balance for Space Station
- Freedom SAF PAPER 9012131 p 323 A90-49288
- WATER IMMERSION Work enhancement and thermal changes during

intermittent work in cool water after carbohydrate loading [AD-A222877] p 315 N90-27247

- WATER MANAGEMENT Hygiene and water in Space Station
- p 331 A90-49414 [SAE PAPER 901386] WATER QUALITY
  - Quality assessment of plant transpiration water

[SAE PAPER 901230] p 323 A90-49301 Space Station Environmental Health System water quality monitoring

[SAE PAPER 901351] p 329 A90-49384 A volatile organics concentrator for use in monitoring Space Station water quality

[SAE PAPER 901352] p 329 A90-49385 Influence of iodine on the treatment of spacecraft humidity condensate to produce potable water

[SAE PAPER 901355] p 329 A90-49388 Recent experiences with iodine water disinfection in Shuttle

p 329 A90-49389 [SAE PAPER 901356] Assessment of internal contamination problems associated with bioregenerative air/water purification systems

**ISAE PAPER 9013791** p 330 A90-49407 WATER RECLAMATION

- Water recycling system for CELSS environment in space
- [SAE PAPER 901208] p 322 A90-49283 Optimal configuration and operation for the Space Shuttle Freedom ECLSS

[SAE PAPER 901212] p 323 A90-49287 Water recovery and management test support modeling for Space Station Freedom

[SAE PAPER 901214] p 323 A90-49289 Quality assessment of plant transpiration water

p 323 A90-49301 [SAE PAPER 901230] Engineering testbed for biological water/air reclamation

and recycling [SAE PAPER 901231] p 324 A90-49302 Water recycling in space

p 325 A90-49317 [SAE PAPER 901247] Human subjects concerns in ground based ECLSS

testing - Managing uncertainty in closely recycled systems [SAE PAPER 901251] p 325 A90-49320

Test bed design for evaluating the Space Station ECLSS Water Recovery System [SAE PAPER 901253] p 325 A90-49322

Facility for generating crew waste water product for ECLSS testing [SAE PAPER 901254]

p 325 A90-49323

Liquid Chromatography/Mass Spectrometry - A new technique for water recovery system testing [SAE PAPER 901255] p 326 A90-49324 Space Station Environmental Health System water

quality monitoring [SAE PAPER 901351] p 329 A90-49384 Detection of gas loading of the water onboard Space

Station Freedom		
[SAE PAPER 901353]	p 329	A90-49386
New total organic carbon analyzer		

[SAE PAPER 901354] p 329 A90-49387 WATER TREATMENT

Water recycling in space p 325 A90-49317 [SAE PAPER 901247]

New total organic carbon analyzer [SAE PAPER 901354] p 329 A90-49387 Influence of iodine on the treatment of spacecraft humidity condensate to produce potable water

p 329 A90-49388 [SAE PAPER 901355] Recent experiences with iodine water disinfection in

Shuttle p 329 A90-49389 [SAE PAPER 901356]

Application of the pentaiodide strong base resin disinfectant to the U.S. space program p 331 A90-49408 **ISAE PAPER 9013801** 

WAVE PROPAGATION

The effects of blast trauma (impulse noise) on hearing: A parametric study source 2

(AD-A2217311 p 316 N90-27253 WEIGHT REDUCTION

- Design considerations for future planetary space suits [SAE PAPER 901428] p 333 A90-49429
- WEIGHTLESSNESS Work/control stations in Space Station weightlessness [SAE PAPER 901203]

SAE PAPER 901203) p 322 A90-49278 Space Station Crew Quarters and Personal Hygiene Facility [SAE PAPER 901301] p 328 A90-49353

Detection of gas loading of the water onboard Space Station Freedom [SAE PAPER 901353]

p 329 A90-49386 WORKLOADS (PSYCHOPHYSIOLOGY)

- Internal representation, internal model, human performance model and mental workload
- p 317 A90-47500 The integrated area measure of visual endogenous ERPs: Relation to cognitive workload and hemisphere p 318 N90-27255 [AD-A223191]
- Real-time measurement of mental workload using psychophysiological measures
- [AD-A221462] p 319 N90-27258 Electrocardiogram of military aircraft pilots measured during real flight missions: Study of the variability of the cardiac rhythm in correlation with working stress
- p 316 N90-28324 WORKSTATIONS
- Work/control stations in Space Station weightlessness p 322 A90-49278 [SAE PAPER 901203] IVA and EVA work place design for a man-tended system
- p 332 A90-49423 [SAE PAPER 901415] A vision-based telerobotic control station

p 336 N90-27311 Robot dynamics in reduced gravity environment p 336 N90-27333

(FTN-90-97453)

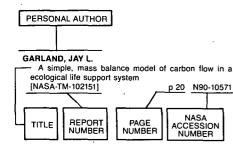
# PERSONAL AUTHOR INDEX

AEROSPACE MEDICINE AND BIOLOGY / A Continuing Bibliography (Supplement 343)

# December 1990

AUTHOR

# Typical Personal Author Index Listing



Listings in this index are arranged alphabetically by personal author. The title of the document provides the user with a brief description of the subject matter. The report number helps to indicate the type of document listed (e.g., NASA report, translation, NASA contractor report). The page and accession numbers are located beneath and to the right of the title. Under any one author's name the accession numbers are arranged in sequence with the AIAA accession numbers appearing first.

#### ABELE, HERMANN

Atmosphere trace gas contamination management for the COLUMBUS pressurized modules p 327 A90-49348

Α

- [SAE PAPER 901288] AGRELLA, MARTIN
- Design definition of the Space Station Freedom Galley and Wardroom subsystems and their effect on Space Station Environmental Systems
- ISAE PAPER 9012991 p 327 A90-49351 AHROON, WILLIAM A.
- The effects of blast trauma (impulse noise) on hearing: A parametric study source 2 IAD-A2217311 p 316 N90-27253
- AKABOSHI, MITSUHIKO

Selective decomposition of either enantiomer or aspartic acid irradiated with Co-60 gamma rays in the mixed aqueous solution with D- or L-alanine p 338 A90-48093

#### AMES, BRIAN E.

- LSOPP II A program for advanced EVA system modeling and trade studies p 326 A90-49332 [SAE PAPER 901264]
- AMMANN, KLAUS
- Atmosphere trace gas contamination management for the COLUMBUS pressurized modules
- **[SAE PAPER 901288]** p 327 A90-49348 ANAZAWA, SEI-ICHI
- Capture control for manipulator arm of free-flying space robot [AIAA PAPER 90-3432] p 321 A90-47685
- ANGELI, J. W.
- Space Station Freedom science support equipment [SAE PAPER 901302] p 328 A90-49354 ANNO, G. H.
- Effects of protracted ionizing radiation dosage on humans and animals: A brief review of selected investigations
- [AD-A222240] p 309 N90-27241 Effects of ionizing radiation on the performance of
- selected tactical combat crews [AD-A222880] p 315 N90-27248

#### AOKI, TOSHIAKI

- The measurement of dark adaptation level in the presence of glare
- p 316 N90-28323 [PB90-155987] APEL, UWE
- Common approach for planetary habitation systems implementation (SAE PAPER 901417) p 332 A90-49425
- ARNO, ROGER D.
- Facilities for animal research in space with special reference to Space Station Freedom p 308 A90-49355 [SAE PAPER 901303]
- Research centrifuge accommodations on Space Station Freedom [SAE PAPER 901304] p 308 A90-49356
- ARNOLD, WILLIAM
- Cockpit Ocular Recording System (CORS) [NASA-CR-4281] p 314 p 314 N90-27244 ASHIDA, AKIRA
- Water recycling system for CELSS environment in space
- [SAE PAPER 901208] p 322 A90-49283 ATWELL, WILLIAM
- Astronaut exposure to space radiation Space Shuttle experience
- ISAE PAPER 9013421 p 313 A90-49377 AZUMA, RONALD
- Tracking a head-mounted display in a room-sized environment with head-mounted cameras [AD-A222545] p 335 N90-27266

# В

- BACSKAY, ALLEN S.
- Water recovery and management test support modeling for Space Station Freedom
- p 323 A90-49289 ISAE PAPER 9012141 Computer, aided system engineering and analysis (CASE/A) modeling package for ECLS systems - An overview
- SAE PAPER 901267 p 327 A90-49336 BAGIAN, JAMES P.
- Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations
- p 330 A90-49390 **ISAE PAPER 9013571** Heart rate and pulmonary function while wearing the launch-entry crew escape suit (LES) during + Gx acceleration and simulated Shuttle launch
- p 330 A90-49391 [SAE PAPER 901358] BALDES, E. J.
- Partial supination versus Gz protection p 311 A90-48592
- BARBER, ANDREW V. Visual mechanisms and predictors of far field visual task p 311 A90-48700 performance
- BARBIER, BERNARD Chemical activity of simple basic peptides
- p 339 A90-48096 BARKER, R. S.
- Application of a comprehensive G189A ECLSS model in assessing specific Space Station conditions [SAE PAPER 901265] p 326 A90-49333
- BARREAU, J. M. Hygiene and water in Space Station
- SAE PAPER 901386] p 331 A90-49414 BASILE, L.
- Habemsi study A study on human factors for space station design
- ISAF PAPER 9014161 p 332 A90-49424 BAUM, S. J.
- Effects of protracted ionizing radiation dosage on humans and animals: A brief review of selected investigations [AD-A222240] p 309 N90-27241
- BAUMGARTNER, NEAL Altitude decompression sickness - Hyperbaric therapy
- results in 528 cases p 311 A90-48589 BAUNE, JACQUELINE

p 331 A90-49413

Alternative hygiene concepts ISAE PAPER 9013851

### BAUNE, MANFRED

- IVA and EVA work place design for a man-tended system [SAE PAPER 901415]
- p 332 A90-49423 BAZHENOV, IU. I.
- Participation of cerebral noradrenergic structures in thermoregulation during the adaptation to cold p 306 A90-48199
- BAZIIAN, B. KH.
- Evoked potentials during periods of look fixation and periods of saccadic eye movement in humans p 309 A90-46520
- **BEHRENS, VIRGINIA**
- Criteria for a recommended standard: Occupational exposure to hand-arm vibration [PB90-168048] p 337 N90-28331
- BELCHER, JEWELL G., JR.
- Rotationally actuated prosthetic helping hand NASA-CASE-MFS-28426-1 p 334 N90-27261
- **BENIGNUS, VERNON A.** Neurobehavioral effects of carbon monoxide (CO)
- exposure in humans: Elevated carboxyhemoglobin (COHb) and cerebrovascular responses [AD-A222840] p 314 N90-27246
- BENSON, BRIAN L.
- Quality assessment of plant transpiration water [SAE PAPER 901230] p 323 A90 p 323 A90-49301 Liquid Chromatography/Mass Spectrometry - A new
- technique for water recovery system testing [SAE PAPER 901255] p 326 A90-49324
- BÈNUM, B.
- Hermes-crew integration aspects [SAE PAPER 901390] p 332 A90-49417 BERSILLON, J.-L.
- Water recycling in space
- SAE PAPER 901247 p 325 A90-49317 BEZARD, J. P.
- Toxicological aspects of fire onboard aircrafts: Role of the pressurization and ventilation in the cockpit p 337 N90-28335
- [ETN-90-97452] BICHI. A.
- Hygiene and water in Space Station
- p 331 A90-49414 SAE PAPER 901386 BIEGL, CSABA A.
- Simulation-based intelligent robotic agent for Space Station Freedom p 335 N90-27298 BISCARDI, JEFFREY K.
- Garment pressurizing apparatus p 336 N90-28330 (AD-D014451)
- BISHOP. GARY
- Tracking a head-mounted display in a room-sized environment with head-mounted cameras p 335 N90-27266 (AD-A222545)
- BLOKLAND, W
  - A study on diagnosability of space station ECLSS p 335 N90-27294

# BODEK, ITAMAR

- A volatile organics concentrator for use in monitoring Space Station water quality SAE PAPER 901352] p 329 A90-49385
- BOIKO, V. I.
- The effect of hyperthermia on the cardiovascular system and acid-base composition of blood in dogs p 305 A90-46523

### BOLSTAD, G.

upport systems

SAE PAPER 9012571

- Hermes-crew integration aspects [SAE PAPER 901390] p 332 A90-49417 BOMAR, JOHN B.
- Positive pressure breathing for acceleration protection and its role in prevention of inflight G-induced loss of p 311 A90-48591 consciousness
- BONASSO, R. PETER
- Creature co-op: Achieving robust remote operations with a community of low-cost robots p 336 N90-27303 BONTING, SJOERD L.
- Facilities for animal research in space with special reference to Space Station Freedom SAE PAPER 901303 p 308 A90-49355
- BONURA MARIO S. Operational ninety-day manned test of regenerative life

p 326 A90-49326

**B-1** 

### **BOUNDS, B. KEITH**

BOUNDS, B. KEITH	
Assessment of internal associated with bioregenera	contamination problems tive air/water purification
systems [SAE PAPER 901379]	p 330 A90-49407

BOYCE, JOEY B. Space Station Freedom CHeCS overview p 312 A90-49327

[SAE PAPER 901258] BOYLE, MICHAEL Survival of pathogenic bacteria under nutrient starvation

conditions [SAE PAPER 901381] p 308 A90-49409

BRACK, ANDRE Chemical activity of simple basic peptides

p 339 A90-48096 BROCK-UTNE, J. G.

Anti-LPS antibodies reduce endotoxemia in whole body Co-60 irradiated primates - A preliminary report p 306 A90-48584

BROCKMAN, W. H.

Three-dimensional camera space manipulation p 320 A90-46400

- BRODY, ADAM R.
- Manual control aspects of Space Station docking maneuvers **ISAE PAPER 9012021** p 321 A90-49277
- BROWN, MARIANN F. Requirements for extravehicular activities on the lunar
- and Martian surfaces p 333 A90-49428 (SAE PAPER 901427)
- BRUBAKK, A. O. Hermes-crew integration aspects [SAE PAPER 901390]
- p 332 A90-49417 BUITEKANT, ALAN
- Facility for generating crew waste water product for ECLSS testing [SAE PAPER 901254]
- p 325 A90-49323 BURTON, RUSSELL R.
- Heart rate and pulmonary function while wearing the launch-entry crew escape suit (LES) during + Gx acceleration and simulated Shuttle launch
- p 330 A90-49391 [SAE PAPER 901358] С

#### CAMPBELL, CANDACE

- Constraints and rationale for Space Station Freedom Habitation and laboratory module topology p 327 A90-49350 [SAE PAPER 901297]
- CAPUTO, MICHAEL Intraocular pressure, retinal vascular, and visual acuity changes during 48 hours of 10-deg head-down tilt p 310 A90-48586
- CARDEN, JAMES R.
- Rotationally actuated prosthetic helping hand [NASA-CASE-MFS-28426-1] p 334 N90-27261 CARRASQUILLO, ROBYN L.
- Phase III Simplified Integrated Test (SIT) results Space Station ECLSS testing
- [SAE PAPER 901252] p 325 A90-49321 CARRETTA, THOMAS R.
- Cross-validation of experimental USAF pilot training performance models AD-A2222531 p 319 N90-27257

CASE. CARL M.

Life support function and technology analysis for future missions [SAE PAPER 901216] p 323 A90-49291

CASSERLY, DENNIS M.

- Identifying atmospheric monitoring needs for Space Station Freedom (SAE PAPER 901383) p 331 A90-49411
- CHAIKINA, L. A. The chronic effect of an electrostatic field on certain
- biochemical indices of tissues p 305 A90-46524 CHARLES, JOHN B.
- Computer simulation of cardiovascular changes during extended duration space flights p 314 A90-49392
- [SAE PAPER 901359] CHEN. I.
- Resolution of seven-axis manipulator redundancy: p 336 N90-27331 heuristic issue CHI, VERNON
- Tracking a head-mounted display in a room-sized environment with head-mounted cameras p 335 N90-27266 (AD-A2225451
- CHICK, T. W. Effects of acute hypoxia on cardiopulmonary responses
- to head-down tilt p 310 A90-48583 CHRISTIAN, STEVE
- Advanced air revitalization system modeling and testing [SAE PAPER 901332] p 328 A90-49370

- CHU. WEN-HO
- Optimal configuration and operation for the Space Shuttle Freedom ECLSS [SAE PAPER 901212] p 323 A90-49287
- CIOLETTI, L. A.
- Microbiology facilities aboard Space Station Freedom (SSF) [SAE PAPER 901262] p 308 A90-49330
- CODE, C. F. Partial supination versus Gz protection
- p 311 A90-48592 COHEN, JONATHAN D.
- A network model of catecholamine effects Gain, p 317 A90-47247 signal-to-noise ratio, and behavior COHEN, MARC M.
- Designing space habitats for human productivity [SAE PAPER 901204] p 322 A90 p 322 A90-49279 COKER, CINDY
- Robot dynamics in reduced gravity environment p 336 N90-27333
- COLLET, J.
- Hygiene and water in Space Station [SAE PAPER 901386] p 331 A90-49414 CONGER, BRUCE C.
- Integrated model of G189A and Aspen-plus for the transient modeling of extravehicular activity atmospheric control systems
- [SAE PAPER 901268] p 326 A90-49335 CONVERT. ODILE
- Chemical structure of a prebiotic analog of adenosine p 305 A90-46654 COOK. GEORGE E.
- Simulation-based intelligent robotic agent for Space Station Freedom p 335 N90-27298 CORCORAN, MERYL L.
- The susceptibility of rhesus monkeys to motion p 306 A90-48585 sickness
- COSTELLO, EREDERICK A Low-temperature thermal control for a lunar base
- SAE PAPER 901242] p 324 A90-49312 CREAGER, GERALD J
- Formulation, preparation and delivery of parenteral fluids for the Space Station Freedom Health Maintenance Facility [SAE PAPER 901325] p 313 A90-49365
- CROWLEY, JOHN S. Human factors and safety considerations of night vision
- systems flight using thermal imaging systems AD-A2232261
- p 334 N90-27263 CRUMP. WILLIAM J.
- Human subjects concerns in ground based ECLSS testing - Managing uncertainty in closely recycled systems [SAE PAPER 901251]
- p 325 A90-49320 CUTLER, LYNN
- 3-D components of a biological neural network visualized in computer generated imagery. II - Macular neural network p 307 A90-49049 organization CYNADER, MAX S.
- Curvature estimation in orientation selection [AD-A221481] .p 315 N90-27249

# D

- DALEE, ROBERT C. Computer aided system engineering and analysis (CASE/A) modeling package for ECLS systems - An overview SAE PAPER 901267
- DALL-BAUMANN, LIESE Advanced air revitalization system modeling and
- p 328 A90-49370
- [SAE PAPER 901384]
- The susceptibility of rhesus monkeys to motion sickness p 306 A90-48585
- The effects of blast trauma (impulse noise) on hearing:
- (AD-A221731) p 316 N90-27253 DAVIS, WILLIAM S.
- Agent independent task planning p 335 N90-27276 DEAN, W. G., JR.
- Space Station Freedom science support equipment [SAE PAPER 901302] p 328 A90-49354 p 328 A90-49354 DECRAMER, L.
- Emulation of the Eva Soviet suit for neutral buoyancy simulations [SAE PAPER 901246] p 324 A90-49316
- DEFRANCISCO, P.
- Hermes-crew integration aspects [SAE PAPER 901390] p 332 A90-49417

#### PERSONAL AUTHOR INDEX

DELANNOY, J. P. Toxicological aspects of fire onboard aircrafts. Role of the pressurization and ventilation in the cockpit FTN-90-974521 p 337 N90-28335 DEMARCO, JEFFERY J. Engineering testbed for biological water/air reclamation and recycling ISAE PAPER 9012311 p 324 A90-49302 DEMPSTER, WILLIAM F. Biosphere 2 project status - Design of a closed manned terrestrial ecological system SAE PAPER 901233 p 324 A90-49303 DEWBERRY, BRANDON S. Space Station Freedom ECLSS: A step toward autonomous regenerative life support systems p 335 N90-27297 DIAMANT, BRYCE L. Past and present environmental control and life support systems on manned spacecraft [SAE PAPER 901210] p 323 A90-49285 DICK, A. O. Cockpit Ocular Recording System (CORS) [NASA-CR-4281] p 314 p 314 N90-27244 DIENER. M. Development of the suit enclosure of the European EVA soace suit [SAE PAPER 901244] p 324 A90-49314 DIETZ. LOUIS P. Space Station Crew Quarters and Personal Hygiene Facility [SAE PAPER 901301] p 328 A90-49353 DOERRE, GARY L. Space Station Crew Quarters and Personal Hygiene Facility [SAE PAPER 901301] p 328 A90-49353 DOLL. SUSAN C. Life support function and technology analysis for future missions [SAE PAPER 901216] p 323 A90-49291 DORE, M. A. Effects of ionizing radiation on the performance of selected tactical combat crews p 315 N90-27248 [AD-A222880] DOUBT, T. J. Work enhancement and thermal changes during intermittent work in cool water after carbohydrate loading [AD-A222877] p 315 N90-27247 DRAGANIC. Z. D. Radiation-induced polymerization in dilute aqueous p 305 A90-46655 solutions of cyanides DRUMMER, C. Hormonal changes after parabolic flight - Implications on the development of motion sickness p 311 A90-48588 DUBIEL, MELISSA Y. Phase III Simplified Integrated Test (SIT) results - Space Station ECLSS testing [SAE PAPER 901252] p 325 - A90-49321 DUBOWSKY, S. The kinematics and dynamics of space manipulators The virtual manipulator approach p 320 A90-46399 DUDEK, HEINZ-LEO Scope and conception of the pilot support system ASPIO [LRT-WE-13-FB-88-1] p 337 N90-28334 DURAND, J. Toxicological aspects of fire onboard aircrafts: Role of the pressurization and ventilation in the cockpit p 337 N90-28335 [ETN-90-97452] DZENITIS, JOHN Active thermal control systems for lunar and Martian exploration [SAE PAPER 901243] p 324 A90-49313 Ε

# EBRINGER, LIBOR

Different effects of eubacterial and eukaryotic DNA topoisomerase II inhibitors on chloroplasts of Euglena oracilis p 306 A90-48100 EDEER, MARYBETH Advanced air revitalization system modeling and

testing		
[SAE PAPER 901332]	p 328	A90-49370
EGGEMEIER. F. THOMAS		

- Automatic information processing and high performance skills: Application to training
- [AD-A221709] p 319 N90-27259 EHLERS, HORST K. F.
- Space Station Freedom contamination requirements and predictions

[SAE PAPER 901408]	p 332	A90-49418
--------------------	-------	-----------

- p 327 A90-49336
- testing [SAE PAPER 901332]
- DAMS, R. A. J. Critical technologies - Spacecraft habitability
- p 331 A90-49412 DAUNTON, NANCY G.
- DAVIS, ROBERT I.
- A parametric study source 2

## PERSONAL AUTHOR INDEX .

# EHNTHOLT, DANIEL J.

A volatile organics concentrator for use in monitoring Space Station water quality

[SAE PAPER 901352] p 329 A90-49385 EHRLICH, WILHELM

Selective decomposition of either enantiomer or aspartic acid irradiated with Co-60 gamma rays in the mixed aqueous solution with D- or L-alanine

p 338 A90-48093 ELLIS, STEPHEN R.

Manual control aspects of Space Station docking maneuvers

ISAE PAPER 9012021 p 321 A90-49277 The dynamics of orbital maneuvering: Design and evaluation of a visual display aid for human controllers

p 336 N90-27767 The effects of training on errors of perceived direction in perspective displays

- [NASA-TM-102792] p 319 N90-28329 ESKEW, R. T., JR.
- The effects of luminance boundaries on color perception
- p 315 N90-27251 [AD-A221544] EWERT, MICHAEL K.
- Active thermal control systems for lunar and Martian exploration p 324 A90-49313 [SAE PAPER 901243]
- EYLES, JOHN
- Tracking a head-mounted display in a room-sized environment with head-mounted cameras p 335 N90-27266 (AD-A222545)
- EZELL, TIMOTHY G.
- Test bed design for evaluating the Space Station ECLSS Water Recovery System [SAE PAPER 901253] p 325 A90-49322
- F

#### FEDOROV, A. I.

- Use of automated systems for the assessment of the health and the adaptive potentials of humans
- p 310 A90-46521 FERNANDEZ, KENNETH R. Simulation-based intelligent robotic agent for Space
- p 335 N90-27298 Station Freedom FILONENKO, V. B.
- Pumping equipment of autonomous inhabited systems [SAE PAPER 901250] p 325 A90-49319 -FISK, ARTHUR D.
- Automatic information processing and high performance skills: Acquisition, transfer, and retention
- p 319 N90-27260 [AD-A221744] FLANAGAN, DAVID T. Recent experiences with iodine water disinfection in
- Shuttle p 329 A90-49389 SAE PAPER 9013561
- FLEISCHAKER, GAIL RANEY Origins of life - An operational definition
- p 339 A90-48095 FOGLEMAN, GUY
- Impact constraints on the environment for chemical evolution and the continuity of life p 339 A90-48101 FORD, TIM
- Survival of pathogenic bacteria under nutrient starvation conditions [SAE PAPER 901381]
- p 308 A90-49409 FOX, ROBERT A.
- The susceptibility of rhesus monkeys to motion p 306 A90-48585 sickness FRANZEN, JOCHEN
- Atmosphere trace gas contamination management for the COLUMBUS pressurized modules [SAE PAPER 901288] p 327 A90-49348
- FUCHS, HENRY
- Tracking a head-mounted display in a room-sized environment with head-mounted cameras AD-A222545] p 335 N90-27266
- FUJII, HIBONORI A preliminary study on experimental simulation of
- dynamics of space manipulator system [AIAA PAPER 90-3399] p 321 A90-47654
- Capture control for manipulator arm of free-flying space robot p 321 A90-47685 [AIAA PAPER 90-3432]
- FUJIL T. Human requirements for quality life in lunar base
- SAE PAPER 901207 p 322 A90-49282 FUNKE, HELMUT
- ECLS technology development programme Results and further activities
- p 327 A90-49349 [SAE PAPER 901289] FURMAN, JOSEPH M. R.
- Nystagmus responses in a group of normal humans during earth-horizontal axis rotation p 317 A90-49046

Visual-vestibutar interaction in humans during p 317 A90-49048 earth-horizontal axis rotation Earth horizontal axis rotational responses in patients with unilateral peripheral vestibular deficits

p 318 A90-49069 Eyes open versus eyes closed - Effect on human p 318 A90-49070 rotational responses

# G

- GAFFIN, S. L.
- Anti-LPS antibodies reduce endotoxemia in whole body Co-60 irradiated primates - A preliminary report p 306 A90-48584
- GARDNER, ANDREA M.
- Computer simulation of a regenerative life support system for a lunar base [SAE PAPER 901329] p 328 A90-49368
- GARDNER, WARREN
- Assessment of internal contamination problems associated with bioregenerative air/water purification systems p 330 A90-49407
- SAE PAPER 9013791 GASKA, JAMES P.
- Non-linear analysis of visual cortical neurons [AD-A221543] p 315 N90-27250
- GAWRONSKI, W. On dynamics and control of multi-link flexible space
- manipulators [AIAA PAPER 90-33961 p 320 A90-47651
- GEISELMAN ERIC F Automatic information processing and high performance
- skills: Application to training LAD-A2217091 p 319 N90-27259
- GERMAIN, J. C. Hygiene and water in Space Station
- [SAE PAPER 901386] p 331 A90-49414 GIBBONS, RANDALL E.
- Recent experiences with iodine water disinfection in Shuttle
- [SAE PAPER 901356] p 329 A90-49389 GILKEY, ROBERT H.
- Binaural masking: An analysis of models p 315 N90-27252 [AD-A221668]
- GILLINGHAM, KENT K.
- A case of left hypoglossal neurapraxia following G exposure in a centrifuge p 311 A90-48590 GLASER. PETER
- Development of the Space Station Freedom Refrigerator/Freezer and Freezer
- p 328 A90-49352 [SAE PAPER 901300] GODEC, RICHARD D.
- New total organic carbon analyzer [SAE PAPER 901354] p 329 A90-49387
- GOLUB, MORTON A.
- Generation rates and chemical compositions of waste streams in a typical crewed space habitat [NASA-TM-102799] p 337 N90-28333
- GORTAN, C.
- Emulation of the Eva Soviet suit for neutral buoyancy simulations [SAE PAPER 901246] p 324 A90-49316
- GOSBEE, JOHN
- Design and evaluation of an electronic stethoscope system for the Space Station Freedom HMF
- p 313 A90-49363 [SAE PAPER 901323] GRANITZ, ANDREA B
- Automatic information processing and high performance skills: Application to training
- p 319 N90-27259 [AD-A2217091 GREENISEN, M. C.
- Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations [SAE PAPER 901357]
- p 330 A90-49390 GREENLEAF, JOHN E.
- Human exercise capabilities in space [SAE PAPER 901200] p 312 A90-49276 GRISHAM, TOLLIE
- Robot dynamics in reduced gravity environment p 336 N90-27333
- GRUNWALD, ARTHUR J.
- The dynamics of orbital maneuvering: Design and evaluation of a visual display aid for human controllers p 336 N90-27767 GUREVICH, M. I.
- The effect of hyperthermia on the cardiovascular system
- and acid-base composition of blood in dogs p 305 A90-46523 **GUSTAVINO, STEPHEN R.**
- Computer simulation of a regenerative life support system for a lunar base
- [SAE PAPER 901329] p 328 A90-49368

# HOPKINS, WILLIAM D.

# н

HABERMAN, K. J.

Work enhancement and thermal changes during intermittent work in cool water after carbohydrate loading p 315 N90-27247 [AD-A222877] HAMERNIK, ROGER P. The effects of blast trauma (impulse noise) on hearing: A parametric study source 2 [AD-A221731] p 316 N90-27253 HARADA, KAZUO Template-directed oligomerization of 5-prime-deoxy 5-nucleosideacetic acid derivatives p 339 A90-48098 HARDING, RICHARD M. Positive pressure breathing for acceleration protection and its role in prevention of inflight G-induced loss of consciousness p 311 A90-48591 HARGENS, A. R.

Scientific uses and technical implementation of a variable gravity centrifuge on Space Station Freedom p 330 A90-49393 [SAE PAPER 901360] HARRIS, BERNARD A.

- Space Station requirements for in-flight exercise countermeasures [SAE PAPER 901259] p 312 A90-49328
- HASTINGS, WOODY The 1989 Gordon Research Conference on Chronobiology [AD-A221972] p 309 N90-28322 HATTORI, A. Status of JEM ECLSS design
- ISAE PAPER 901209) p 322 A90-49284 HAVENITH, G.
- Physiological reactions to heat stress; quantifying the effects of individual parameters [IZF-1989-30] p 316 N90-28326
- Calculation of clothing insulation and vapour resistance [IZF-1989-49]

A generalized photosynthetic model for plant growth

Criteria for a recommended standard: Occupational

Atmosphere Composition Monitor for predevelopment

Atmosphere Composition Monitor for predevelopment

Automatic information processing and high performance

A model for a space shuttle safing and failure-detection

Oxidation kinetics of model compounds of metabolic

Report on the workshop - 'Chemical evolution and

Selective decomposition of either enantiomer or aspartic

Effects of competition on video-task performance in

acid irradiated with Co-60 gamma rays in the mixed

neo-abiogenesis in marine hydrothermal systems'

Superhelicity and DNA radiation sensitivity

aqueous solution with D- or L-alanine

skills: Acquisition, transfer, and retention

Robot dynamics in reduced gravity environment

Space Station

[SAE PAPER 901259]

[SAE PAPER 901331]

HENSCHEL, AUSTIN

[PB90-168048]

HINMAN, FLAINE

HODGE, KEVIN A.

IAD-A2217441

HOLGATE. HENRY R.

[SAF PAPER 901333]

[SAE PAPER 901349]

aste in supercritical water

HOEY, JOHN

HOLM. NILS G.

HOLWITT, ERIC A.

HÒNDA, YASUHIRO

HOPKINS, WILLIAM D.

monkeys (Macaca mulatta)

expert

HISS, JEFF

HEPPNER, RICHARD A.

operational system test

(SAE PAPER 901256)

operational system test

[SAE PAPER 901256]

within a closed artificial environment

exposure to hand-arm vibration

countermeasures

HEATH, ROBERT L.

p 338 N90-28338 HAYASHI, MASATO Dynamics and positioning control of space robot with 5

֥.

.

~

1.1.

40

flexible manipulators. p 320 A90-47652 [AIAA PAPER 90-3397] HAYES, JUDITH C.

requirements for in-flight exercise

p 312 A90-49328

p 308 A90-49369

p 337 N90-28331

p 326 A90-49325

p 336 N90-27333

p 326 A90-49325

p 319 N90-27260

p 336 N90-27314

p 328 A90-49371

p 305 A90-48091

p 308 A90-49383

p 338 A90-48093

p 317 A90-49039

**B-3** 

#### HORD, DAVID J.

#### HORD DAVID J

- The integrated area measure of visual endogenous ERPs: Relation to cognitive workload and hemisphere n.318 N90-27255 [AD-A223191] HORKACHUK, MICHAEL J.
- Research centrifuge accommodations on Space Station Freedom
- [SAE PAPER 901304] p 308 A90-49356 HORNET, D. Emulation of the Eva Soviet suit for neutral buoyancy
- simulations p 324 A90-49316 [SAE PAPER 901246]
- HOU. JACK C.-H. Changes in geometrical and biomechanical properties
- of immature male and female rat tibia p 306 A90-48587 HOUSE, J. F.
- Work enhancement and thermal changes during intermittent work in cool water after carbohydrate loading
- [AD-A222877] p 315 N90-27247 HOWARD, J. A., JR.
- Detection of gas loading of the water onboard Space Station Freedom
- (SAE PAPER 901353) p 329 A90-49386 HSU. VICTOR
- Energy-rich glyceric acid oxygen esters Implications for the origin of glycolysis p 339 A90-48097 HSUEH, KENG D.
- The effects of blast trauma (impulse noise) on hearing: A parametric study source 2
- [AD-A221731] p 316 N90-27253 HUMPHREY, DARRYL
- Real-time measurement of mental workload using psychophysiological measures [AD-A221462] p 319 N90-27258
- HUMPHRIES, W. R. Past and present environmental control and life support
- systems on manned spacecraft [SAE PAPER 901210] p 323 A90-49285
- Space Station Freedom Environmental Control and Life Support System design - A status report [SAE PAPER 901211] p 3
- p 323 A90-49286 HUNTER, MORWOOD Intraocular pressure, retinal vascular, and visual acuity
- changes during 48 hours of 10-deg head-down tilt p 310 A90-48586 HURD, RACHEL M. S.
- A generalized photosynthetic model for plant growth
- within a closed artificial environment [SAE PAPER 901331] p 308 A90-49369 HUTTE, RICHARD S.
- New total organic carbon analyzer [SAE PAPER 901354] p 329 A90-49387
- HUTTENBACH, ROBIN C. Life support - Thoughts on the design of safety
- systems [SAE PAPER 901248] p 325 A90-49318

L

- IH C-H.C On dynamics and control of multi-link flexible space
- manipulators [AIAA PAPER 90-3396] p 320 A90-47651 IIKURA, SHOUICHI
- Smart end effector for dexterous manipulation in space
- [AIAA PAPER 90-3434] p 321 A90-47687 IOVINE, JOHN V.
- LSOPP II A program for advanced EVA system modeling and trade studies
- [SAE PAPER 901264] p 326 A90-49332 IWATA, TOSHIAKI
- Smart end effector for dexterous manipulation in snace [AIAA PAPER 90-3434] p 321 A90-47687
- IZUTANI, NAOAKI
- Miniaturization study of heat exhausting radiator of lunar base [SAE PAPER 901206] p 322 A90-49281
- J

JACOBS, GILDA

**B-4** 

- A methodology for choosing candidate materials for the fabrication of planetary space suit structures (SAE PAPER 901429) p 333 p 333 A90-49430 JACOBSON, LOWELL D.
- Non-linear analysis of visual cortical neurons [AD-A221543] p 315 N90-27250
- JAMES, JOHN T. Space Station Freedom viewed as a 'tight building' [SAE PAPER 901382] p 331 A90-49410

- JANG. W. S.
- Three-dimensional camera space manipulation p 320 A90-46400 JANIK, DANIEL S.

- Quality assessment of plant transpiration water [SAE PAPER 901230] p 323 A90-49301 Engineering testbed for biological water/air reclamation and recycling
- (SAE PAPER 901231) p 324 A90-49302 Human subjects concerns in ground based ECLSS testing - Managing uncertainty in closely recycled systems (SAE PAPER 901251) p 325 A90-49320
- JENG, FRANK
- Advanced air revitalization system modeling and testing [SAE PAPER 901332] p 328 A90-49370
- JESSL, ROLE
- European Space Station health care system concept SAE PAPER 901387] p 332 A90-49415 JOHANNSEN, GUNNAR
- Internal representation, internal model, human performance model and mental workload p 317 A90-47500
- JOHNSON, ANNE H.
  - Assessment of internal contamination problems associated with bioregenerative air/water purification ISAE PAPER 901379]
- p 330 A90-49407 JOHNSON C.C.
- Scientific uses and technical implementation of a variable gravity centrifuge on Space Station Freedom [SAE PAPER 901360] p 330 A90-49393 JORDAAN, J. P.
- Anti-LPS antibodies reduce endotoxemia in whole body Co-60 irradiated primates - A preliminary report p 306 A90-48584
- JORGENSEN, L. B. Water recycling in space
- [SAE PAPER 901247] p 325 A90-49317

# Κ

- KAMERER, DONALD B. Earth horizontal axis rotational responses in patients with unilateral peripheral vestibular deficits
- p 318 A90-49069
- KAPLICKY, JAN Spacecraft accommodation strategies for manned Mars missions
- [SAE PAPER 901418] p 333 A90-49426 KASSIL', G. N.
- Stress-induced deficits of the human immune system p 310 A90-48331
- KATCHEN, MARC S.
- A case of left hypoglossal neurapraxia following G p 311 A90-48590 exposure in a centrifuge KAWAL KENICHI
- Selective decomposition of either enantiomer or aspartic acid irradiated with Co-60 gamma rays in the mixed aqueous solution with D- or L-alanine
- p 338 A90-48093 KAZIN. E. M.
- Use of automated systems for the assessment of the health and the adaptive potentials of humans
- p 310 A90-46521 KELLY, TAMSIN LISA
- Melatonin, light and, circadian cycles [AD-A223196] p p 318 N90-27256
- KERGUELEN, P. C. M.
- Toxicological aspects of fire onboard aircrafts: Role of the pressurization and ventilation in the cockpit [ETN-90-97452] p 337 N90-28335
- KHINE, M. Hermes-crew integration aspects
- [SAE PAPER 901390] p 332 A90-49417 KIBE. SEISHIRO
- Japanese research activities of life support system [SAE PAPER 901205] p 322 A90-49280 KIHM. E.
- Hygiene and water in Space Station [SAE PAPER 901386] p 331 A90-49414
- KILGORE, MELVIN V., JR.
- . Liquid Chromatography/Mass Spectrometry A new technique for water recovery system testing [SAE PAPER 901255] p 326 A90-49324
- -KING. C. C. Did membrane electrochemistry precede translation?
- p 305 A90-46652 KISHIYAMA, JENNY S.
- Facilities for animal research in space with special reference to Space Station Freedom [SAE PAPER 901303] p 308 A90-49355

#### PERSONAL AUTHOR INDEX

#### KNORR, WOLFRAM

- ECLS technology development programme Results and further activities ISAE PAPER 901289] p 327 A90-49349
- KNOX, JAMES C. Computer aided system engineering and analysis
- (CASE/A) modeling package for ECLS systems An . overview [SAE PAPER 901267] p 327 A90-49336
- KOBAYASHI, KENSEI
- Abiotic synthesis of amino acids and imidazole by proton irradiation of simulated primitive earth atmosphere p 338 A90-48092
- KOENIG. A.

gracilis

KRAMER, ARTHUR F.

AD-A221462]

nercention

[AD-A221544]

KRUPA, DEBRA L.

accelerations

KUBARKO, A. I.

space

KWAN, AL

KUZ'MIN, S. N.

psychophysiological measures

Plant biology research on 'LifeSat' [SAE PAPER 901227]

KRIKORIAN, ABRAHAM D.

KRONAUER, RICHARD E.

Space Station Freedom

[SAE PAPER 901326]

KRUTZ, ROBERT W., JR.

[SAE PAPER 901357]

[SAE PAPER 901358]

KUROKAWA, HIDEAKI

[SAE PAPER 901208]

[SAE PAPER 901299]

LAGROSSA, CHARLES

NASA-CR-4281

LAIRD, JOHN E.

LAM, TONY

organization

[AD-A221744]

LEE, MARK D.

[AD-A222909]

in small doses, on body temperature

- Hormonal changes after parabolic flight Implications on the development of motion sickness p 311 A90-48588
- KOLODNEY, MATTHEW
- Integrated model of G189A and Aspen-plus for the transient modeling of extravehicular activity atmospheric control systems [SAE PAPER 901268] p 326 A90-49335 KOMATSU, TADASHI
- Smart end effector for dexterous manipulation in space
- [AIAA PAPER 90-3434] p 321 A90-47687 KÖSENKA, PAUL P. New total organic carbon analyzer
- SAE PAPER 901354] p 329 A90-49387 KOSMO, JOSEPH J.
- Design considerations for future planetary space suits [SAE PAPER 901428] p 333 A90-49429
- KRAJCOVIC, JURAJ Different effects of eubacterial and eukarvotic DNA topoisomerase II inhibitors on chloroplasts of Euglena

Real-time measurement of mental workload using

The effects of luminance boundaries on color

Medical concerns for Assured Crew Return Vehicle from

Reach performance while wearing the Space Shuttle

Heart rate and pulmonary function while wearing the launch-entry crew escape suit (LES) during  $+\mbox{ Gx}$  acceleration and simulated Shuttle launch

The influence of serotonine and histamine, introduced

Water recycling system for CELSS environment in

Stress-induced deficits of the human immune system

Design definition of the Space Station Freedom Galley

3-D components of a biological neural network visualized

Automatic information processing and high performance

in computer generated imagery. II - Macular neural network

and Wardroom subsystems and their effect on Space Station Environmental Systems

Cockpit Ocular Recording System (CORS)

Symbolic architectures for cognition

skills: Acquisition, transfer, and retention

launch and entry suit during exposure to launch

p 306 A90-48100

p 319 · N90-27258

p 307 A90-49299

p 315 N90-27251

p 313 A90-49366

p 330 A90-49390

p 330 A90-49391

p 306 A90-48200

p 322 A90-49283

p 310 A90-48331

p 327 A90-49351

p 314 N90-27244

p 318 N90-27254

p 307 A90-49049

p 319 N90-27260

# PERSONAL AUTHOR INDEX

#### LEE, TAE-YEONG A prototype computer-aided modelling tool for life-support system models [SAE PAPER 901269] n 327 A90-49337 LEISEIFER, H. P. Integrated air/water cooling concepts for space laboratory modules [SAE PAPER 901370] p 330 A90-49400 LEONARD, JOEL I. Computer simulation of cardiovascular changes during extended duration space flights [SAE PAPER 901359] p 314 A90-49392 LEVANDO, V. A. Stress-induced deficits of the human immune system p 310 A90-48331 LEVETON, LAUREN B. Crew selection, productivity and well-being for human exploration missions [SAE PAPER 901362] p 318 A90-49395 LIMERO, THOMAS F. Space Station Freedom viewed as a 'tight building' ISAE PAPER 901382] p 331 A90-49410 LIN. CHIN Advanced air revitalization system modeling and testing [SAE PAPER 901332] p 328 A90-49370 LINDENTHAL, A. Habemsi study - A study on human factors for space station design p 332 A90-49424 LITOVITZ, T A. Mechanisms of microwave induced damage in biologic materiats (AD-A222454) p 309 N90-27242 LITTLE, FRANK A prototype computer-aided modelling tool for life-support system models ISAE PAPER 901269] p 327 A90-49337 LIUBIMOV. N. N. Evoked potentials during periods of look fixation and periods of saccadic eye movement in humans p 309 A90-46520 LLOYD, WILLIAM P. Constraints and rationale for Space Station Freedom Habitation and laboratory module topology [SAE PAPER 901297] p 32 p 327 A90-49350 1 LOCKHEAD, GREGORY'R. Conference on The Perception of Structure Program and Abstracts [AD-A222437] p 319 N90-28328 LOEPPKY, J. A. Effects of acute hypoxia on cardiopulmonary responses to head-down tilt p 310 A90-48583 LOMAX. CURTIS A direct-interface fusible heat sink for astronaut cooling [SAE PAPER 901433] p 333 A90-49434 LONG, DAVID A. Test bed design for evaluating the Space Station ECLSS Water Recovery System [SAE PAPER 901253] p 325 A90-49322 LOTENS, W. A: Physical characteristics of clothing materials with regard to heat transport

[IZF-1989-10] p 337 N90-28336 Calculation of clothing insulation and vapour resistance [IZF-1989-49] p 338 N90-28338

LUCOT, JAMES B. RU 24969-induced emesis in the cat - 5-HT1 sites other

than 5-HT1A, 5-HT1B or 5-HT1C implicated p 307 A90-49041

LUFT, U. C. Effects of acute hypoxia on cardiopulmonary responses p 310 A90-48583 to head-down tilt

LUPANDIN. A. V.

Adaptation of trained and untrained humans to natural and technogenic extreme factors under the effect of adaptogens p 310 A90-46522 LYONS, TERENCE J.

A case of left hypoglossal neurapraxia following G p 311 A90-48590 exposure in a centrifuge

# Μ

MACHIDA, KAZUO

Smart end effector for dexterous manipulation in Dace AIAA PAPER 90-3434

p 321 A90-47687 MACLER, BRUCE A.

Quality assessment of plant transpiration water [SAE PAPER 901230] p 323 A90-49301 MADER. THOMAS H.

Intraocular pressure, retinal vascular, and visual acuity changes during 48 hours of 10-deg head-down tilt p 310 A90-48586 MADORE, MONICA A. A generalized photosynthetic model for plant growth within a closed artificial environment SAF PAPER 9013311 n 308 A90-49369

- MADSEN. R. F. Water recycling in space ISAE PAPER 9012471 p 325 A90-49317 MAGISTAD, JOHN AX-5 space suit reliability model [SAE PAPER 901361] p 330 A90-49394 MAKI, HIROTOSHI Selective decomposition of either enantiomer or aspartic acid irradiated with Co-60 gamma rays in the mixed aqueous solution with D- or L-alanine p 338 A90-48093 MAKI, JAMES Survival of pathogenic bacteria under nutrient starvation conditions [SAE PAPER 901381] p 308 A90-49409 MANKAMYER, MELANIE M. Computer simulation of a regenerative life support system for a lunar base p 328 A90-49368 SAE PAPER 901329] MARCHIN, GEORGE L. Application of the pentaiodide strong base resin disinfectant to the U.S. space program p 331 A90-49408 [SAE PAPER 901380] MARCUS, J. T. Influence of gravito-inertial force on vestibular nystagmus in man (IZF-1989-24) p 316 N90-28325 MARGALIT, RUTH Pseudomonas diagnostic assay [NASA-CASE-NPO-17653-1-CU] p 308 N90-27239 MAUREL, MARIE-CHRISTINE Chemical structure of a prebiotic analog of adenosine p 305 A90-46654 MAYER, J. P. Habemsi study - A study on human factors for space station design (SAE PAPER 901416) p 332 A90-49424 MCANULTY, MICHAEL Human factors research in aircrew performance and training [AD-A221657] p 335 N90-27267 MCCLAIN, EDWARD L. Garment pressurizing apparatus [AD-D014451] p 336 N90-28330 MCKINLEY, BRUCE A. Clinical laboratory diagnosis for space medicine [SAE PAPER 901263] p 312 A90 p 312 A90-49331 Sterile water for injection system for on-site production of IV fluids at Space Station Freedom HMF [SAE PAPER 901324] p 313 A90-49364 MECKLINGER, AXEL Real-time measurement of mental workload using psychophysiological measures p 319 N90-27258 AD-A2214621 MEEHAN, RICHARD T. Intraocular pressure, retinal vascular, and visual acuity changes during 48 hours of 10-deg head-down tilt p 310 A90-48586 MEEKER, LARRY J. Heart rate and pulmonary function while wearing the launch-entry crew escape suit (LES) during + Gx acceleration and simulated Shuttle launch p 330 A90-49391 [SAE PAPER 901358] MEISTER, R. Mechanisms of microwave induced damage in biologic materials [AD-A222454] p 309 N90-27242 MENGERS, DAVID R. Low-temperature thermal control for a lunar base [SAE PAPER 901242] p 324 A90-49312 MERRILL, LEX L. The integrated area measure of visual endogenous ERPs: Relation to cognitive workload and hemisphere
- [AD-A223191] p 318 N90-27255 MERWIN, W. H. JR. The Chinchilla's vestibulo-ocular reflex

p 307 A90-49047 MEYER, GLENN

- 3-D components of a biological neural network visualized in computer generated imagery. II - Macular neural network p 307 A90-49049 organization MIDORIKAWA, Y.
- Human requirements for quality life in lunar base [SAE PAPER 901207] p 322 A90-49282 MIGNET M

Toxicological aspects of fire onboard aircrafts: Role of the pressurization and ventilation in the cockpit p 337 N90-28335 ETN-90-974521

# NEWELL, ALLEN

MIKHAILOVA, L. R.		
<ul> <li>Participation of cerebral norad thermoregulation during the adapta</li> </ul>		
the adapta		A90-48199
MISHRA, S. K.		
Microbiology facilities aboard Sp (SSF)	pace Stati	on Freedom
[SAE PAPER 901262]	p 308	A90-49330
MITANI, KENJI		
Water recycling system for CE	LSS env	ironment in
space (SAE PAPER 901208)	n 399	A90-49283
MITCHELL, RALPH	p 522	A30-43203
Survival of pathogenic bacteria un	nder nutrie	nt starvation
Conditions	- 000	100 10100
[SAE PAPER 901381] MITTLEMAN, K. D.	p 308	A90-49409
Work enhancement and then	mal char	nges during
intermittent work in cool water	after c	arbohydrate
loading (AD-A222877)	0.315	N90-27247
MOHAMADINEJAD, HABIB	p 313	1130-27247
Water recovery and management	test supp	ort modeling
for Space Station Freedom	- 000	
[SAE PAPER 901214] MOHAMED, S. S.	p 323	A90-49289
Model-based iterative learning co	ntrol of S	pace-Shuttle
manipulator		
[AIAA PAPER 90-3398]	p 320	A90-47653
MOHR, R. K. Mechanisms of microwave induc	ed damao	e in hiologic
materials	oo aamag	e in ciologie
[AD-A222454]	p 309	N90-27242
MONTROSE, C. J. Mechanisms of microwave induce	od damaa	o in hiologia
materials	eo uamay	e in biologic
[AD-A222454]	p 309	N90-27242
MOORE, JAMES S., JR.		
Low-temperature thermal control [SAE PAPER 901242]		A90-49312
		700-40012
MORAY, NEVILLE		
MORAY, NEVILLE Internal representation, intern		el, human
	rkload	
Internal representation, intern performance model and mental wo	rkload	el, human A90-47500
Internal representation, intern performance model and mental wor MUCKLE, SUSAN V. Influence of iodine on the tre	rkload p 317 atment o	A90-47500 f spacecraft
Internal representation, intern performance model and mental wor MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po	rkload p 317 atment o table wate	A90-47500 f spacecraft er
Internal representation, intern performance model and mental wor MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po [SAE PAPER 901355]	rkload p 317 atment o table wate	A90-47500 f spacecraft
Internal representation, intern performance model and mental wor MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po	rkload p 317 atment o table wate p 329	A90-47500 f spacecraft er A90-49388
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid	rkload p 317 atment o table wate p 329 d direction	A90-47500 f spacecraft er A90-49388
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M.	rkload p 317 atment o table wate p 329 d direction p 317	A90-47500 f spacecraft er A90-49388 of a moving A90-49062
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct	rkload p 317 atment o table wate p 329 d direction p 317	A90-47500 f spacecraft er A90-49388 of a moving A90-49062
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M.	rkload p 317 atment o table wate p 329 d direction p 317 ed damag	A90-47500 f spacecraft er A90-49388 of a moving A90-49062
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induce materials [AD-A222454] MURAYAMA, TSUTOMU	rkload p 317 atment o table wate p 329 d direction p 317 ed damag p 309	A90-47500 f spacecraft r A90-49388 of a moving A90-49062 e in biologic N90-27242
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator ar	rkload p 317 atment o table wate p 329 d direction p 317 ed damag p 309	A90-47500 f spacecraft r A90-49388 of a moving A90-49062 e in biologic N90-27242
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induce materials [AD-A222454] MURAYAMA, TSUTOMU	rkload p 317 atment o table wate p 329 d direction p 317 ed damag p 309 m of free-	A90-47500 f spacecraft r A90-49388 of a moving A90-49062 e in biologic N90-27242
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator and robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA	rkload p 317 atment o table wate p 329 d direction p 317 ed damag p 309 m of free- p 321	A90-47500 f spacecraft ar A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685
Internal representation, interr performance model and mental wor MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce poo [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator ar robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA Dynamics and positioning control	rkload p 317 atment o table wate p 329 d direction p 317 ed damag p 309 m of free- p 321	A90-47500 f spacecraft ar A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce poo [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator ar robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA Dynamics and positioning control flexible manipulators	rkload p 317 atment o table wate p 329 d direction p 317 ed damag p 309 m of free- p 321 of space	A90-47500 f spacecraft ar A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator ar robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA Dynamics and positioning control flexible manipulators [AIAA PAPER 90-3397] MURRY, ROGER P.	rkload p 317 ratment o table wate p 329 d direction p 317 ed damag p 309 rm of free- p 321 ol of spac- p 320	A90-47500 f spacecraft ar A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685 e robot with
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce poo [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator ar robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA Dynamics and positioning control flexible manipulators [AIAA PAPER 90-3397] MURRY, ROGER P. An air bearing fan for EVA suit ver	rkload p 317 ratment o table wate p 329 d direction p 317 ed damag p 309 rm of free- p 321 ol of spac p 320 entilation	A90-47500 f spacecraft ar A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685 e robot with A90-47652
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator ar robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA Dynamics and positioning control flexible manipulators [AIAA PAPER 90-3397] MURRY, ROGER P.	rkload p 317 ratment o table wate p 329 d direction p 317 ed damag p 309 rm of free- p 321 ol of spac- p 320	A90-47500 f spacecraft ar A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685 e robot with A90-47652
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator ar robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA Dynamics and positioning control flexible manipulators [AIAA PAPER 90-3397] MURRY, ROGER P. An air bearing fan for EVA suit ve [SAE PAPER 901432]	rkload p 317 ratment o table wate p 329 d direction p 317 ed damag p 309 rm of free- p 321 ol of spac p 320 entilation	A90-47500 f spacecraft ar A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685 e robot with A90-47652
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce poo [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator ar robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA Dynamics and positioning control flexible manipulators [AIAA PAPER 90-3397] MURRY, ROGER P. An air bearing fan for EVA suit ver	rkload p 317 ratment o table wate p 329 d direction p 317 ed damag p 309 rm of free- p 321 ol of spac p 320 entilation	A90-47500 f spacecraft ar A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685 e robot with A90-47652
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator ar robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA Dynamics and positioning control flexible manipulators [AIAA PAPER 90-3397] MURRY, ROGER P. An air bearing fan for EVA suit ve [SAE PAPER 901432]	rkload p 317 ratment o table wate p 329 d direction p 317 ed damag p 309 rm of free- p 321 ol of spac p 320 entilation	A90-47500 f spacecraft ar A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685 e robot with A90-47652
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induce materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator ar robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA Dynamics and positioning control flexible manipulators [AIAA PAPER 90-3397] MURRY, ROGER P. An air bearing fan for EVA suit ve [SAE PAPER 901432] NAITOH, PAUL Melatonin, light and, circadian cy	rkload p 317 ratment o table wate p 329 d direction p 317 ed damag p 309 m of free- p 321 ol of spac p 320 entilation p 333	A90-47500 f spacecraft ar A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685 e robot with A90-47652 A90-49433
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce poo [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator an robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA Dynamics and positioning control flexible manipulators [AIAA PAPER 90-3397] MURAY, ROGER P. An air bearing fan for EVA suit ve [SAE PAPER 901432] N NAITOH, PAUL Melatonin, light and, circadian cy [AD-A223196]	rkload p 317 ratment o table wate p 329 d direction p 317 ed damag p 309 m of free- p 321 ol of spac p 320 entilation p 333	A90-47500 f spacecraft ar A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685 e robot with A90-47652
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce po [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induce materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator ar robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA Dynamics and positioning control flexible manipulators [AIAA PAPER 90-3397] MURRY, ROGER P. An air bearing fan for EVA suit ve [SAE PAPER 901432] NAITOH, PAUL Melatonin, light and, circadian cy	rkload p 317 ratment o table wate p 329 d direction p 317 ed damag p 309 rm of free- p 321 of spac- p 320 entilation p 333	A90-47500 f spacecraft ar A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685 e robot with A90-47652 A90-49433
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce poo [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator an robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA Dynamics and positioning control flexible manipulators [AIAA PAPER 90-3437] MURAY, ROGER P. An air bearing fan for EVA suit ve [SAE PAPER 901432] NAITOH, PAUL Melatonin, light and, circadian cy (AD-A223196] NAKAJIMA, KAZUNARI Capture control for manipulator an robot	rkload p 317 ratment o table wate p 329 d direction p 317 ed darmag p 309 rm of free- p 321 ol of spac p 320 entilation p 333 cles p 318 rm of free-	A90-47500 f spacecraft and A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685 e robot with A90-47652 A90-49433 N90-27256 flying space
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce poo [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator ar robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA Dynamics and positioning control flexible manipulators [AIAA PAPER 90-3397] MURRY, ROGER P. An air bearing fan for EVA suit ve [SAE PAPER 901432] NAITOH, PAUL Melatonin, light and, circadian cy [AD-A223196] NAKAJIMA, KAZUNARI Capture control for manipulator ar robot [AIAA PAPER 90-3432]	rkload p 317 ratment o table wate p 329 d direction p 317 ed darmag p 309 rm of free- p 321 ol of spac p 320 entilation p 333 cles p 318 rm of free-	A90-47500 f spacecraft ar A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685 e robot with A90-47652 A90-49433
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce poo [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator an robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA Dynamics and positioning control flexible manipulators [AIAA PAPER 90-3437] MURAY, ROGER P. An air bearing fan for EVA suit ve [SAE PAPER 901432] NAITOH, PAUL Melatonin, light and, circadian cy (AD-A223196] NAKAJIMA, KAZUNARI Capture control for manipulator an robot	rkload p 317 ratment o table wate p 329 d direction p 317 ed damag p 309 m of free- p 321 of space p 320 entilation p 333 cles p 318 rm of free- p 321	A90-47500 f spacecraft ar A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685 e robot with A90-47652 A90-47652 A90-47655 flying space A90-47685
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce poo [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator ar robot [AIAA PAPER 90-3432] MUROTSU, YOSHISADA Dynamics and positioning control flexible manipulators [AIAA PAPER 90-3432] MURAYAR, ROGER P. An air bearing fan for EVA suit ve [SAE PAPER 901432] NAITOH, PAUL Melatonin, light and, circadian cy [AD-A223196] NAKAJIMA, KAZUNARI Capture control for manipulator ar robot [AIAA PAPER 90-3432] NARDONE, R. M. Mechanisms of microwave induct materials	rkload p 317 ratment o table wate p 329 d direction p 317 ed damag p 309 rm of free- p 321 of space p 320 entilation p 333 cles p 318 rm of free- p 321 ed damag	A90-47500 f spacecraft r A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685 e robot with A90-47652 A90-49433 N90-27256 flying space A90-47685 e in biologic
Internal representation, intern performance model and mental work MUCKLE, SUSAN V. Influence of iodine on the tre humidity condensate to produce poo [SAE PAPER 901355] MULLIGAN, J. B. Effect of contrast on the perceived plaid MULLINS, J. M. Mechanisms of microwave induct materials [AD-A222454] MURAYAMA, TSUTOMU Capture control for manipulator an robot [AIAA PAPER 90-3432] MURAYAMA, TSUTOMU Capture control for manipulator an robot [AIAA PAPER 90-3432] MURAYAMA, SOURCE [AIAA PAPER 90-3432] MURAY, ROGER P. An air bearing fan for EVA suit ve [SAE PAPER 901432] NAITOH, PAUL Melatonin, light and, circadian cy [AD-A223196] NAKAJIMA, KAZUNARI Capture control for manipulator an robot [AIAA PAPER 90-3432] NAROONE, R. M. Mechanisms of microwave induct	rkload p 317 ratment o table wate p 329 d direction p 317 ed damag p 309 rm of free- p 321 of space p 320 entilation p 333 cles p 318 rm of free- p 321 ed damag	A90-47500 f spacecraft ar A90-49388 of a moving A90-49062 e in biologic N90-27242 flying space A90-47685 e robot with A90-47652 A90-47652 A90-47655 flying space A90-47685

Deep-space radiation exposure analysis for solar cycle XXI (1975-1986)

- (SAE PAPER 901347) p 314 A90-49381 NEGRON-MENDOZA, A.
- Radiation-induced polymerization in dilute aqueous solutions of cyanides NELSON, GREGORY A. p 305 A90-46655

LifeSat - Radiation research [SAE PAPER 901228] p 307 A90-49300 NEWELL, ALLEN

Symbolic architectures for cognition

[AD-A222909] p 318 N90-27254

# NGO, D. M.

#### NGO. D. M.

- Risk assessment methodologies for target fragments produced in high-energy nucleon reactions p 312 A90-49066
- NISHIMOTO, MITCHELL Changes in geometrical and biomechanical properties of immature male and female rat tibia

p 306 A90-48587 NITTA, K.

- Human requirements for quality life in lunar base p 322 A90-49282 [SAE PAPER 901207] NITTA, KEIJI
- Japanese research activities of life support system SAE PAPER 9012051 p 322 A90-49280 [SAE PAPER 901205] Water recycling system for CELSS environment in
- snace ISAE PAPER 901208] p 322 A90-49283 NIXON, DAVID
- Spacecraft accommodation strategies for manned Mars missions
- [SAE PAPER 901418] p 333 A90-49426
- NORTON, WILLIAM E. Rotationally actuated prosthetic helping hand [NASA-CASE-MFS-28426-1] p 334 N90-27261

Ο

- OBERBECK VERNE R
- Impact constraints on the environment for chemical evolution and the continuity of life p 339 A90-48101 OFHRLE, STUART A.
- Liquid Chromatography/Mass Spectrometry A new technique for water recovery system testing ISAE PAPER 9012551 p 326 p 326 A90-49324
- OGLE, KATHRYN Y. Phase III Simplified Integrated Test (SIT) results - Space Station ECLSS testing
- [SAE PAPER 901252] p 325 A90-49321
- OGURA, TADASHI Miniaturization study of heat exhausting radiator of lunar
- [SAE PAPER 901206] p 322 A90-49281 OHJA, HARUHIKO
- Japanese research activities of life support system [SAE PAPER 901205] p 322 A90-49280 p 322 A90-49280 OLLIVIER, Y.
- Development of the suit enclosure of the European EVA snace suit
- p 324 A90-49314 [SAE PAPER 901244] OLSON, PAUL L.
- The measurement of dark adaptation level in the presence of glare p 316 N90-28323 (PB90-155987)
- ORAM, STEPHEN D. Life support - Thoughts on the design of safety
- systems [SAE PAPER 901248] p 325 A90-49318
- ORGEL, LESLIE E. Template-directed oligomerization of 5-prime-deoxy
- 5-nucleosideacetic acid derivatives p 339 A90-48098 OSHIMA, TAIRO
- Abiotic synthesis of amino acids and imidazole by proton irradiation of simulated primitive earth atmospheres p 338 A90-48092

#### OSHMARIN, I. D.

- Pumping equipment of autonomous inhabited systems [SAE PAPER 901250] p 325 A90-49319 OTSUBO, KOJI
- Japanese research activities of life support system [SAE PAPER 901205] p 322 A90-49280 OTSUKI, F.
- Status of JEM ECLSS design [SAE PAPER 901209] p 322 A90-49284

# Ρ

- PADALKAR, S.
- A study on diagnosability of space station ECLSS p 335 N90-27294
- PAGE, TERRY L. The 1989 Gordon Research Conference on Chronobiology
- p 309 N90-28322 [AD-A221972] PALMER, JOHN R.
- Constraints and rationale for Space Station Freedom Habitation and laboratory module topology p 327 A90-49350 [SAE PAPER 901297]
- PANFEROV, V. A. Use of automated systems for the assessment of the health and the adaptive potentials of humans p 310 A90-46521

### PARANICH, A. V.

The chronic effect of an electrostatic field on certain p 305 A90-46524 biochemical indices of tissues

- PATEL, SANJAY
- Changes in geometrical and biomechanical properties of immature male and female rat tibia n 306 A90-48587
- PATRICK, EUGENE L.
- Bioelectromagnetic effects of the Electromagnetic Pulse (EMP)
- p 309 N90-27243 [AD-A221552] PATTI B
- Integrated air/water cooling concepts for space laboratory modules [SAE PAPER 901370] p 330 A90-49400
- PENAFIEL, M. Mechanisms of microwave induced damage in biologic
- materials p 309 N90-27242 [AD-A222454]
- PEREVERZEV, V. A. The influence of serotonine and histamine, introduced in small doses, on body temperature
- p 306 A90-48200
- PERRY, JAY L. Phase III Simplified Integrated Test (SIT) results Space Station ECLSS testing
- p 325 A90-49321 [SAE PAPER 901252] PERSHIN, B. B.
- Stress-induced deficits of the human immune system p 310 A90-48331 PETETE, PATRICIA A.
- Active thermal control systems for lunar and Martian exploration
- SAE PAPER 901243] p 324 A90-49313 PETROVICK, MATTHEW L.
- Neurobehavioral effects of carbon monoxide (CO) exposure in humans: Elevated carboxyhemoglobin (COHb) and cerebrovascular responses p 314 N90-27246 [AD-A222840]
- PIERSON, DUANE L.
- Space Station Freedom viewed as a 'tight building' [SAE PAPER 901382] p 331 A90-49410 p 331 A90-49410 POLLEN, DANIEL A.
- Non-linear analysis of visual cortical neurons [AD-A221543] p 315 N p 315 N90-27250 POMERANTZ, JAMES
- Conference on The Perception of Structure Program and Abstracts
- IAD-A2224371 p 319 N90-28328 PORTER B
- Model-based iterative learning control of Space-Shuttle manipulator AIAA PAPER 90-3398 p 320 A90-47653
- PRAH. JAMES D.
- Neurobehavioral effects of carbon monoxide (CO) exposure in humans: Elevated carboxyhemoglobin (COHb) and cerebrovascular responses [AD-A222840] p 314 N90-27246
- PREISIG. H. A.
- A prototype computer-aided modelling tool for life-support system models [SAE PAPER 901269] p 327 A90-49337
- PREISS. HELMUT
- and further activities
- PRINTZ, HARRY
- signal-to-noise ratio, and behavior p 317 A90-47247 PROBE, J. D.
- launch and entry suit during exposure to launch accelerations
- [SAE PAPER 901357]

# R

- **RADERMACHER, REINHARD** Low-temperature thermal control for a lunar base p 324 A90-49312 [SAE PAPER 901242] RASH, CLARENCE E.
- Human factors and safety considerations of night vision systems flight using thermal imaging systems p 334 N90-27263 (AD-A223226)
- Human factors and safety considerations of night vision systems flight p 337 N90-28332 [USAARL-89-12]
- REINHARDT, AL AX-5 space suit reliability model
- [SAE PAPER 901361] p 330 A90-49394 REITH, MICHAEL SCOT
- The relationship of isometric grip strength, optimal dynamometer settings, and certain anthropometric factors
- [AD-A222046] p 334 N90-27264

# PERSONAL AUTHOR INDEX

RELITER .I.I Space Station Freedom Environmental Control and Life Support System design - A status report p 323 A90-49286 ISAE PAPER 9012111 RICHARD, ELIZABETH E. Development of the Space Station Freedom Environmental Health System [SAE PAPER 901260] p 312 A90-49329 Microbiology facilities aboard Space Station Freedom (SSF) [SAE PAPER 901262] p 308 A90-49330 RIEPL, R. L. Hormonal changes after parabolic flight - Implications on the development of motion sickness p 311 A90-48588 RIFTIN, A. D. Use of automated systems for the assessment of the health and the adaptive potentials of humans p 310 A90-46521 RITTENBERG, B. G. Pumping equipment of autonomous inhabited systems [SAE PAPER 901250] p 325 A90-49319 p 325 A90-49319 ROBERTS, BARRY C. Phase III Simplified Integrated Test (SIT) results - Space Station ECLSS testing [SAE PAPER 901252] p 325 A90-49321 Facility for generating crew waste water product for ECLSS testing [SAE PAPER 901254] p 325 A90-49323 ROBINSON, F. R. Influence of gravity on cat vertical vestibulo-ocular reflex p 307 A90-49053 ROGERS, WENDY A. Automatic information processing and high performance skills: Acquisition, transfer, and retention p 319 N90-27260 AD-A2217441 ROGUNOV. M. A. Pumping equipment of autonomous inhabited systems [SAE PAPER 901250] p 325 A90-49319 p 325 A90-49319 ROGUS, TIMOTHY E. Automatic information processing and high performance skills: Application to training [AD-A221709] p 319 N90-27259 ROMODANOVA, E. A. The chronic effect of an electrostatic field on certain biochemical indices of tissues p 305 A90-46524 ROSE, S. K. Detection of gas loading of the water onboard Space Station Freedom p 329 A90-49386 [SAE PAPER 901353] ROSENBLOOM, PAUL S. Symbolic architectures for cognition IAD-A2229091 p 318 N90-27254 ROSKE-HOFSTRAND, RENATE J. Human factors in the presentation of computer-generated information - Aspects of design and application in automated flight traffic p 321 A90-49270 ROSS. MURIEL D. 3-D components of a biological neural network visualized in computer generated imagery. II - Macular neural network organization p 307 A90-49049 ROTHENHEBER, EDWARD Cockpit Ocular Recording System (CORS) INASA-CR-42811 p 314 p 314 N90-27244 RUMBAUGH, DUANE M. Effects of competition on video-task performance in monkeys (Macaca mulatta) p 317 A90-49039 RUSSO, DANE Development of the Space Station Freedom Environmental Health System [SAE PAPER 901260] p 312 A90-49329 RUSSO, DANE M. Identifying atmospheric monitoring needs for Space Station Freedom [SAE PAPER 901383] p 331 A90-49411 S

SAGACH, V. F.

The effect of hyperthermia on the cardiovascular system and acid-base composition of blood in dogs p 305 A90-46523 SAIZ, JOHN Development of the Space Station Freedom Refrigerator/Freezer and Freezer ISAE PAPER 9013001 p 328 A90-49352 SARGENT, DONALD H. System level water balance for Space Station Freedom [SAE PAPER 901213] p 323 A90-49288 SARRI, G. Integrated air/water cooling concepts for space laboratory modules [SAE PAPER 901370] p 330 A90-49400

# ECLS technology development programme - Results [SAE PAPER 901289] p 327 A90-49349

- A network model of catecholamine effects Gain,
- Reach performance while wearing the Space Shuttle

p 330 A90-49390

# PERSONAL AUTHOR INDEX

#### SAUER, RICHARD L.

- Space Station Environmental Health System water quality monitoring [SAE PAPER 901351] p 329 A90-49384
- A volatile organics concentrator for use in monitoring Space Station water quality . [SAE PAPER 901352] p 329 A90-49385
- Recent experiences with iodine water disinfection in Shuttle
- [SAE PAPER 901356] p 329 A90-49389 SAWA, TOSHIO
- Water recycling system for CELSS environment in space [SAE PAPER 901208] p 322 A90-49283
- SCHAFER, L. E.
- Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations (SAE PAPER 9013571 p 330 A90-49390
- SCHENTRUP. SUSAN M.
- Requirements for extravehicular activities on the lunar and Martian surfaces [SAE PAPER 901427] p 333 A90-49428
- SCHLEGEL, WILLIAM A case of left hypoglossal neurapraxia following G
- exposure in a centrifuge p 311 A90-48590 SCHULTZ, JOHN R.
- Recent experiences with iodine water disinfection in Shuttle p 329 A90-49389 [SAE PAPER 901356]
- SCHUNK, R. G. Space Station Freedom Environmental Control and Life
- Support System design A status report p 323 A90-49286 [SAE PAPER 901211]
- SCOTTO, P. Effects of acute hypoxia on cardiopulmonary responses
- to head-down tilt SECORD, TERRY C. p 310 A90-48583 Operational ninety-day manned test of regenerative life
- support systems [SAE PAPER 901257] p 326 A90-49326
- SENDA, KEI Dynamics and positioning control of space robot with
- flexible manipulators [AIAA PAPER 90-3397] p 320 A90-47652 SEROKHVOSTOV, ALEKSANDR P.
- Physiological reserves of the human organism and the high-altitude environment p 310 A90-46625
- SERVAN-SCHREIBER, DAVID A network model of catecholamine effects - Gain. signal-to-noise ratio, and behavior p 317 A90-47247
- SHEFER, M. The intrinsic approach to space robotic manipulators
- [AIAA PAPER 90-3431] p 321 A90-47684 SHEPPARD, RODNEY J. Accurate determination of the complex permittivity of
- biological tissue at 90 GHz, 70 GHz, and over a broad band around 35 GHz [AD-A222062] p 309 N90-27240
- SHIBA. M.
- Human requirements for quality life in lunar base ISAE PAPER 901207] p 322 A90-49282 SHIMANSKAIA. T. V.
- The effect of hyperthermia on the cardiovascular system and acid-base composition of blood in dogs p 305 A90-46523
- SHINN, J. L.
- Risk assessment methodologies for target fragments produced in high-energy nucleon reactions p 312 A90-49066

SHINN, JUDY L. Nuclear reaction effects in conventional risk assessment

- p 311 A90-49065 for energetic ion exposure SHORIN, IU. P.
- Use of automated systems for the assessment of the health and the adaptive potentials of humans p 310 A90-46521
- SIMONSEN, LISA C.
- Deep-space radiation exposure analysis for solar cycle XXI (1975-1986)
- [SAE PAPER 901347] p 314 A90-49381 SINCLAIR, WARREN K. Recent developments in estimates of cancer risk from
- ionizing radiation [SAE PAPER 901344] p 313 A90-49379 SIREVAAG, ERIK
- Real-time measurement of mental workload using psychophysiological measures p 319 N90-27258 [AD-A221462]
- SKAAR, S. B. Three-dimensional camera space manipulation
- SKOOG, A. INGEMAR
- p 320 A90-46400

EVA life support design advancements [SAE PAPER 901245] p 3 p 324 A90-49315

- SLEZAK, TERRY N.
- Recent experiences with iodine water disinfection in Shuttle
- [SAE PAPER 901356] p 329 A90-49389 SMITH, D. C.
- Detection of gas loading of the water onboard Space Station Freedom p 329 A90-49386
- (SAE PAPER 901353) SMITH. DEBORAH
- Melatonin, light and, circadian cycles p 318 N90-27256 [AD-A223196] SMITH. J. M.
- Space Station Freedom science support equipment p 328 A90-49354 SAE PAPER 901302] SOULEZ-LARIVIERE, C.
- Critical technologies Spacecraft habitability [SAE PAPER 901384] p 331
- p 331 A90-49412 SPEICHER, JAMES M.
- Superhelicity and DNA radiation sensitivity p 308 A90-49383 [SAE PAPER 901349] SPRINGFIELD, JAMES F.
- Simulation-based intelligent robotic agent for Space Station Freedom p 335 N90-27298
- SRINIVASAN, R. SRINI
- Computer simulation of cardiovascular changes during extended duration space flights [SAE PAPER 901359] p 314 A90-49392
- STAAB, J. P.
- Influence of gravity on cat vertical vestibulo-ocular reflex p 307 A90-49053 STASSEN, HENK G.
- Internal representation, internal model, human performance model and mental workload
- p 317 A90-47500
- STEINSIEK, FRANK Common approach for planetary habitation systems implementation
- [SAE PAPER 901417] p 332 A90-49425 STEVENSON, DAVID M.
- Oxidation kinetics of model compounds of metabolic waste in supercritical water p 328 A90-49371
- [SAE PAPER 901333] STOKES, JAMES
- Cockpit Ocular Recording System (CORS) [NASA-CR-4281] p 314 N90-27244 STONE, L. S.
- Effect of contrast on the perceived direction of a moving p 317 A90-49062 olaid
- STONE, LYDIA
- Crew selection, productivity and well-being for human exploration missions [SAE PAPER 901362] p 318 A90-49395
- STROLLO, F.
- Hormonal changes after parabolic flight Implications on the development of motion sickness p 311 A90-48588
- STROMEYER, C. F., III
- The effects of luminance boundaries on color perception
- AD-A2215441 p 315 N90-27251 STROMEYER. H.
- Hormonal changes after parabolic flight Implications on the development of motion sickness p 311 A90-48588
- SUGAHARA, KOHJI
- A preliminary study on experimental simulation of dynamics of space manipulator system p 321 A90-47654
- [AIAA PAPER 90-3399] SUZDAL'SKII, R. S.
- Stress-induced deficits of the human immune system p 310 A90-48331 SUZUKI, T.
- Status of JEM ECLSS design [SAE PAPER 901209] p 322 A90-49284
- SWANSON, THEODORE D.
- Low-temperature thermal control for a lunar base [SAE PAPER 901242] p 324 A90-49312
- SWENBERG, CHARLES E.
- Superhelicity and DNA radiation sensitivity [SAE PAPER 901349] p 308 p 308 A90-49383 SYMONS, JAMES M.
- Influence of iodine on the treatment of spacecraft humidity condensate to produce potable water [SAE PAPER 901355] p 329 p 329 A90-49388
- SZTIPANOVITS, J. A study on diagnosability of space station ECLSS
- p 335 N90-27294

# Т

TAN. GIJSBERT

- ECLS technology development programme Results and further activitie
- p 327 A90-49349 [SAE PAPER 9012891

TAYLOR. GERALD R.

- Intraocular pressure, retinal vascular, and visual acuity changes during 48 hours of 10-deg head-down tilt p 310 A90-48586 TAYLOR, R.
- Microbiology facilities aboard Space Station Freedom (SSF)
- [SAE PAPER 901262] p 308 A90-49330 TAYLOR, ROBERT D.
- Space Station Freedom viewed as a 'tight building' [SAE PAPER 901382] p 331 A90-49410
- TESTER, JEFFERSON W.

THARP. GREGORY K.

[NASA-TM-102792]

THEEUWES, J.

THIEMANN, W.

THOMAS, L. DALE

THOMASSEN, J. R.

[SAE PAPER 901251]

Water recycling in space [SAE PAPER 901247]

targets [IZF-1989-22]

systems

THORP. J. W.

[AD-A222877]

TILLOTSON, BRIAN

TODA, YOSHITSUGU

[AIAA PAPER 90-3434]

[SAE PAPER 901246]

operational system test

TOWNSEND, LAWRENCE W.

for energetic ion exposure

Space Station water quality

sembly for HERMES

[SAE PAPER 901256]

XXI (1975-1986) [SAE PAPER 901347]

ISAE PAPER 9013521

ISAE PAPER 901287]

[AAS PAPER 89-440]

TSUCHIYA, MASAHIKO

flexible manipulators AIAA PAPER 90-33971

TURRENTINE, GEORGE A.

A parametric study source 2

TRAXLER, GERHARD

TSUCHIYA, KAZUO

TSUJIO, SHOZO

[AD-A221731]

TRABANINO, RUDY

loading

space

TOGNINI, M.

imulations

TORRES, DIEGO A.

TOMKO, D. L.

reflex

in perspective displays

TEUTSCH. H.

Oxidation kinetics of model compounds of metabolic waste in supercritical water [SAE PAPER 901333] p 328 A90-49371

Possible amplification of enantiomer excesses through

The effects of training on errors of perceived direction

Categorization and identification of simultaneous

Possible amplification of enantiomer excesses through

Human subjects concerns in ground based ECLSS

Work enhancement and thermal changes during

Smart end effector for dexterous manipulation in

Emulation of the Eva Soviet suit for neutral buoyancy

Influence of gravity on cat vertical vestibulo-ocular

Atmosphere Composition Monitor for predevelopment

Nuclear reaction effects in conventional risk assessment

Deep-space radiation exposure analysis for solar cycle

A volatile organics concentrator for use in monitoring

The development of the Human Waste Collection

Abiotic synthesis of amino acids and imidazole by proton

Dynamics and positioning control of space robot with

The effects of blast trauma (impulse noise) on hearing:

Trajectory planning for a space manipulator

irradiation of simulated primitive earth atmospheres

intermittent work in cool water after carbohydrate

A vision-based telerobotic control station

The Chinchilla's vestibulo-ocular reflex

testing - Managing uncertainty in closely recycled

structural properties of liquid crystals - A model for origin

of optical activity in the biosphere? p 338 A90-48094

p 319 N90-28329

p 338 N90-28337

p 325 A90-49320

p 325 A90-49317

p 315 N90-27247

p 336 N90-27311

p 321 A90-47687

p 324 A90-49316

p 307 A90-49047

p 307 A90-49053

p 326 A90-49325

p 311 A90-49065

p 314 A90-49381

p 329 A90-49385

p 327 A90-49347

p 320 A90-46827

p 338 A90-48092

p 320 A90-47652

p 316 N90-27253

**B-7** 

١

structural properties of liquid crystals - A model for origin

of optical activity in the biosphere? p 338 A90-48094

# · U

- A preliminary study on experimental simulation of dynamics of space manipulator system [AIAA PAPER 90-3399] p 321 A90-47654
- UCHIYAMA, TAKASHI A preliminary study on experimental simulation of
- dynamics of space manipulator system [AIAA PAPER 90-3399] p 321 A90-47654

#### VAETH, ROLAND

- EVA life support design advancements [SAE PAPER 901245] p 324 A90-49315 VAFA, Z.
- The kinematics and dynamics of space manipulators -The kinematics and dynamics of space manipulators -The virtual manipulator approach p 320 A90-46399 VAILAS, ARTHUR C.
- Changes in geometrical and biomechanical properties of immature male and female rat tibia
- p 306 A90-48587 VALENTINE, JAMES R.
- A volatile organics concentrator for use in monitoring Space Station water quality
- [SAE PAPER 901352] p 329 A90-49385 VALS, E.
- Toxicological aspects of fire onboard aircrafts: Role of the pressurization and ventilation in the cockpit
- [ETN-90-97452] p 337 N90-28335 VANLEHN, KURT A.
- Rule acquisition events in the discovery of problem solving strategies [AD-A222428] p 334 N90-27265
- VANMIDDENDORP, H. Physiological reactions to heat stress; quantifying the
- VASIL'EV, V. N. Pumping equipment of autonomous inhabited systems
- Pumping equipment of autonomous inhabited systems [SAE PAPER 901250] p 325 A90-49319 VAULT, WILLIAM L.
- Bioelectromagnetic effects of the Electromagnetic Pulse (EMP)
- [AD-A221552] p 309 N90-27243 VAZIRI, PARSHAW
- 3-D components of a biological neural network visualized in computer generated imagery. II - Macular neural network organization p 307 A90-49049
- VERONA, ROBERT W.
- Human factors and safety considerations of night vision systems flight using thermal imaging systems [AD-A223226] p 334 N90-27263
- Human factors and safety considerations of night vision systems flight (USAARL-89-12) p 337 ' N90-28332
- VEST, THOMAS W. Rotationally actuated prosthetic helping hand
- Rotationally actuated prosthetic helping hand [NASA-CASE-MFS-28426-1] p 334 N90-27261 VIAL, D.
- Water recycling in space [SAE PAPER 901247] p 325 A90-49317 VINCZE, JOHANNA E.
- Space Station Environmental Health System water quality monitoring
- [SAE PAPER 901351] p 329 A90-49384 A volatile organics concentrator for use in monitoring Space Station water quality [SAE PAPER 901352] p 329 A90-49385
- VON JOUANNE, R. G. Application of a comprehensive G189A ECLSS model
- in assessing specific Space Station conditions [SAE PAPER 901265] p 326 A90-49333 VUJOSEVIC, S. I.
- Radiation-induced polymerization in dilute aqueous solutions of cyanides p 305 A90-46655

## W

WAECHTERSHAEUSER, GUENTER

**B-8** 

- The case for the chemoautotrophic origin of life in an iron-sulfur world p 339 A90-48099 WALL, C., III
- Influence of gravity on cat vertical vestibulo-ocular reflex p 307 A90-49053 WALL, CONRAD, III
- Nystagmus responses in a group of normal humans during earth-horizontal axis rotation p 317 A90-49046
- The Chinchilla's vestibulo-ocular reflex p 307 A90-49047 Visual-vestibular interaction in humans during
- Visual-vestibular interaction in humans during earth-horizontal axis rotation p 317 A90-49048

- Earth horizontal axis rotational responses in patients with unilateral peripheral vestibular deficits p 318 A90-49069
- Eyes open versus eyes closed Effect on human rotational responses p 318 A90-49070 WANG, JIH-FANG
- A real-time optical 6D tracker for head-mounted display systems
- (AD-A222884) p 334 N90-27262 Tracking a head-mounted display in a room-sized environment with head-mounted cameras
- [AD-A222545] p 335 N90-27266 WANG, S. J.
- On dynamics and control of multi-link flexible space manipulators [AIAA PAPER 90-3396] p 320 A90-47651
- WASHBURN, DAVID A.
- Effects of competition on video-task performance in monkeys (Macaca mulatta) p 317 A90-49039 WATSON. A. B.
- Effect of contrast on the perceived direction of a moving plaid p 317 A90-49062 WEBBON. B. W.
- A direct-interface fusible heat sink for astronaut
- cooling {SAE PAPER 901433} p 333 A90-49434 WEBER, ARTHUR L.
- Energy-rich glyceric acid oxygen esters Implications for the origin of glycolysis p 339 A90-48097.
- WEBLEY, PAUL A. Oxidation kinetics of model compounds of metabolic waste in supercritical water
- [SAE PAPER 901333] p 328 A90-49371
- WEIEN, ROBERT W. Altitude decompression sickness - Hyperbaric therap
- results in 528 cases p 311 A90-48589 WELLS, M. T. Anti-LPS antibodies reduce endotoxemia in whole body
  - Co-60 irradiated primates A preliminary report p 306 A90-48584
- WERNER, WALTER N.
- Garment pressurizing apparatus [AD-D014451] p 336 N90-28330 WESSELS, B. C.
- Anti-LPS antibodies reduce endotoxemia in whole body Co-60 irradiated primates - A preliminary report p 306 A90-48584
- WHITE, WELDON L.
- Medical information BUS Integrated monitoring for the HMF of Space Station Freedom
- [SAE PAPER 901328] p 313 A90-49367 WHITLEY, KEN M.
- Phase III Simplified Integrated Test (SIT) results Space Station ECLSS testing [SAE PAPER 901252] p 325 A90-49321
- [SAE PAPER 901252] p 325 A90-49321 WICKENS, CHRISTOPHER D.
- The integration of complex information from auditory and visual channels under stress [AD-A222686] p 314 N90-27245
- WILLITS, CHARLES
- Work/control stations in Space Station weightlessness [SAE PAPER 901203] p 322 A90-49278 WILSON, J. W.
- Risk assessment methodologies for target fragments produced in high-energy nucleon reactions
- p 312 A90-49066 WILSON, JOHN W.
- Nuclear reaction effects in conventional risk assessment for energetic ion exposure p 311 A90-49065 Deep-space radiation exposure analysis for solar cycle XXI (1975-1986)
- [SAE PAPER 901347] p 314 A90-49381 WINISDOERFFER, F.
- Habitability studies for Hermes A status of simulation and validation [SAE PAPER 901388] p 332 A90-49416
- [SAE PAPER 901388] p 332 A90-49416 WOOD, E. H. Partial supination versus Gz protection
- p 311 A90-48592 WORKMAN, GARY L.
- Robot dynamics in reduced gravity environment p 336 N90-27333
- WYDEVEN, THEODORE Generation rates and chemical compositions of waste streams in a typical crewed space habitat [NASA-TM-102799] p 337 N90-28333
  - -- p 337 N9L

# Y

- YAMADA, KATSUHIKO
- Trajectory planning for a space manipulator [AAS PAPER 89-440] p 320 A90-46827 YAMAGUCHI, N.
- Status of JEM ECLSS design [SAE PAPER 901209] p 322 A90-49284

#### YAMAMOTO, HIROYASU

- Miniaturization study of heat exhausting radiator of lunar base
- [SAE PAPER 901206] p 322 A90-49281 YANAGAWA, HIROSHI
- Abiotic synthesis of amino acids and imidazole by proton irradiation of simulated primitive earth atmospheres p 338 A90-48092
- YOSHIDA, Y.
  - Status of JEM ECLSS design [SAE PAPER 901209] p 322 A90-49284

# Ζ

ZAGRIADSKII, VIKTOR P.

[AD-A221481]

Physiological reserves of the human organism and the high-altitude environment p 310 A90-46625 ZEILINGOLD, DAPHNA

A model for a space shuttle safing and failure-detection expert p 336 N90-27314 ZELON, JON

Design definition of the Space Station Freedom Galley and Wardroom subsystems and their effect on Space Station Environmental Systems

- [SAE PAPER 901299] p 327 A90-49351 Development of the Space Station Freedom Refrigerator/Freezer and Freezer
- [SAE PAPER 901300] p 328 A90-49352 ZERNICKE, RONALD F.

Changes in geometrical and biomechanical properties of immature male and female rat tibia

Curvature estimation in orientation selection

p 306 A90-48587 ZUCKER, STEVEN W.

p 315 N90-27249

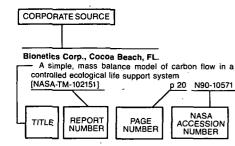
UCHIYAMA, KENJI

# CORPORATE SOURCE INDEX

# AEROSPACE MEDICINE AND BIOLOGY / A Continuing Bibliography (Supplement 343)

#### December 1990

# **Typical Corporate Source** Index Listing



Listings in this index are arranged alphabetically by corporate source. The title of the document is used to provide a brief description of the subject matter. The page number and the accession number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document.

# Α

- Air Force Human Resources Lab., Brooks AFB, TX. Cross-validation of experimental USAF pilot training performance models AD-A2222531
- p 319 N90-27257 Air Force Office of Scientific Research, Bolling AFB,
- Washington, DC. AX-5 space suit reliability model [SAE PAPER 901361] p 330 A90-49394
- Alabama A & M Univ., Normal. Resolution of seven-axis manipulator redundancy: A
- p 336 N90-27331 heuristic issue Alabama Univ., Huntsville.
- Quality assessment of plant transpiration water p 323 A90-49301 [SAE PAPER 901230] Human subjects concerns in ground based ECLSS testino -Managing uncertainty in closely recycled systems [SAE PAPER 901251]
- p 325 A90-49320 Allied-Signal Aerospace Co., Torrance, CA.
- An air bearing fan for EVA suit ventilation (SAE PAPER 901432) p 333 490.49433
- Anacapa Sciences, Inc., Fort Rucker, AL. Human factors research in aircrew performance and training
- p 335 N90-27267 [AD-A221657] Analytics, Inc., Willow Grove, PA. Cockpit Ocular Recording System (CORS)
- [NASA-CR-4281] p 314 N90-27244 Army Aeromedical Research Lab., Fort Rucker, AL. Human factors and safety considerations of night vision systems flight using thermal imaging systems
- [AD-A223226] p 334 N90-27263 Human factors and safety considerations of night vision
- systems flight p 337 N90-28332 [USAARL-89-12]

# В

•		
Boeing Aerospace Co., Huntsville, AL A vision-based telerobotic control s		
	p 336	N90-27311
Boeing Co., Huntsville, AL. Agent independent task planning	p 335	N90-27276
Boeing Co., Seattle, WA. Facility for generating crew waste ECLSS testing	water	product for

ISAF PAPER 9012541 p 325 A90-49323

# С

- California Univ., La Jolla.
- Energy-rich glyceric acid oxygen esters Implications n 339 A90-48097 for the origin of glycolysis California Univ., Los Angeles.
- Changes in geometrical and biomechanical properties of immature male and female rat tibia
- p 306 A90-48587 Carnegie-Mellon Univ., Pittsburgh, PA
- Symbolic architectures for cognition
- p 318 N90-27254 [AD-A222909] Rule acquisition events in the discovery of problem solving strategies
- p 334 N90-27265 [AD-A222428] Catholic Univ. of America, Washington, DC.
- Mechanisms of microwave induced damage in biologic materials p 309 N90-27242 |AD-A222454|
- Central Inst. for the Deaf, Saint Louis, MO.
- Binaural masking: An analysis of models p 315 N90-27252 [AD-A221668]
- Centre d'Essais en Vol, Bretigny-sur-Orge (France). Toxicological aspects of fire onboard aircrafts: Role of the pressurization and ventilation in the cockpit p 337 N90-28335
- IETN-90-974521 Colorado Univ., Denver. Intraocular pressure, retinal vascular, and visual acuity
- changes during 48 hours of 10-deg head-down tilt p 310 A90-48586
- Costello (Frederick A.), Inc., Herndon, VA. Low-temperature thermal control for a lunar base [SAE PAPER 901242] p 324 A90-49312

# D

- Dayton Univ., OH.
- Automatic information processing and high performance skills: Application to training [AD-A221709] p 319 N90-27259
- Department of the Navy, Washington, DC. Garment pressurizing apparatus [AD-D014451] p 336 N90-28330 Duke Univ., Durham, NC. Conference on The Perception of Structure Program and
- Abstracts p 319 · N90-28328 1 AD-A222437

# Ε

- Environmental Protection Agency, Research Triangle Park, NC.
- Neuropehavioral effects of carbon monoxide (CO) exposure in humans: Elevated carboxyhemoglobin (COHb) and cerebrovascular responses p 314 N90-27246
- [AD-A222840] European Office of Aerospace Research and
- Development, London (England). Accurate determination of the complex permittivity of biological tissue at 90 GHz, 70 GHz, and over a broad band around 35 GHz [AD-A222062]
  - p 309 N90-27240

# G

- General Electric Co., Schenectady, NY.
- The kinematics and dynamics of space manipulators -The virtual manipulator approach p 320 A90-46399 Georgia Inst. of Tech., Atlanta.
- Automatic information processing and high performance skills: Acquisition, transfer, and retention IAD-A2217441 p 319 N90-27260
- Georgia State Univ., Atlanta, Effects of competition on video-task performance in
- p 317 A90-49039 monkeys (Macaca mulatta) Gordon Research Conferences, Inc., Kingston, RI. The 1989 Gordon Research Conference
- Chronobiology [AD-A221972] p 309 N90-28322

# н

- Hampton Univ., VA.
- Risk assessment methodologies for target fragments produced in high-energy nucleon reactions p 312 A90-49066
- Harry Diamond Labs., Adelphi, MD. Bioelectromagnetic effects of the Electromagnetic Pulse
- (EMP) p 309 N90-27243 IAD-A2215521 Harvard Medical School, Boston, MA. Visual-vestibular interaction earth-horizontal axis rotation humans during in p 317 A90-49048 Harvard Univ., Cambridge, MA. Survival of pathogenic bacteria under nutrient starvation conditions [SAE PAPER 901381] p 308 A90-49409 The effects of luminance boundaries on color
- perception [AD-A221544] p 315 N90-27251 Houston Univ., Clear Lake, TX.
- Identifying atmospheric monitoring needs for Space Station Freedom
- p 331 A90-49411 [SAE PAPER 901383] Houston Univ., TX.
- Influence of iodine on the treatment of spacecraft humidity condensate to produce potable water p 329 A90-49388 [SAE PAPER 901355]
- 1.

# Illinois Univ., Savoy.

- The integration of complex information from auditory and visual channels under stress p 314 N90-27245
- AD-A2226861 Institute for Perception RVO-TNO, Soesterberg

# (Netherlands).

- Influence of gravito-inertial force on vestibular nystagmus in man [IZF-1989-24] p 316 N90-28325
- Physiological reactions to heat stress; quantifying the effects of individual parameters
- [IZF-1989-30] p 316 N90-28326 Physical characteristics of clothing materials with regard to heat transport
- p 337 N90-28336 [IZF-1989-10] Categorization and identification of simultaneous targets
- [IZF-1989-22] p 338 N90-28337 Calculation of clothing insulation and vapour resistance p 338 N90-28338 [IZF-1989-49]

# J

# Jet Propulsion Lab., California Inst. of Tech.,

- Pasadena. On dynamics and control of multi-link flexible space manipulators
- | AIAA PAPER 90-3396 | p 320 A90-47651 LifeSat - Radiation research
- p 307 A90-49300 [SAE PAPER 901228]

#### Kansas State Univ.

Pseudomonas diagnostic assay [NASA-CASE-NPO-17653-1-CU] p 308 N90-27239

# Κ

- Kansas State Univ., Manhattan,
- Application of the pentaiodide strong base resin disinfectant to the U.S. space program p 331 A90-49408 (SAE PAPER 901380)
- Kings Coll., London (England). Accurate determination of the complex permittivity of biological tissue at 90 GHz, 70 GHz, and over a broad
- hand around 35 GHz IAD-A2220621 p 309 N90-27240
- Krug International, Houston, TX. Intraocular pressure, retinal vascular, and visual acuity changes during 48 hours of 10-deg head-down tilt p 310 A90-48586
- Space Station requirements for in-flight exercise countermeasures
- [SAE PAPER 901259] o 312 A90-49328 Development of the Space Environmental Health System Station Freedom
- p 312 A90-49329 [SAE PAPER 901260] Microbiology facilities aboard Space Station Freedom
- (SSF) [SAE PAPER 901262] p 308 A90-49330 Recent experiences with iodine water disinfection in
- Shuttle (SAE PAPER 901356) n 329 A90-49389
- Computer simulation of cardiovascular changes during extended duration space flights p 314 A90-49392 [SAE PAPER 901359]
- Space Station Freedom viewed as a 'tight building' p 331 A90-49410 SAE PAPER 9013821
- Krug International, San Antonio, TX. Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations
- p 330 A90-49390 [SAE PAPER 901357] Heart rate and pulmonary function while wearing the launch-entry crew escape suit (LES) during + Gx acceleration and simulated Shuttle launch
- [SAE PAPER 901358] p 330 A90-49391

# L

- Little (Arthur D.), Inc., Cambridge, MA.
- A volatile organics concentrator for use in monitoring Space Station water quality
- [SAE PAPER 901352] p 329 A90-49385 Lockheed Engineering and Sciences Co., Houston, TX. Integrated model of G189A and Aspen-plus for the transient modeling of extravehicular activity atmospheric
- control systems [SAE PAPER 901268] p 326 A90-49335 Advanced air revitalization system modeling and
- testing [SAE PAPER 901332] p 328 A90-49370
- Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations
- [SAE PAPER 901357] p 330 A90-49390 Lockheed Engineering and Sciences Co., Washington, DC.
- Computer simulation of cardiovascular changes during extended duration space flights [SAE PAPER 901359]
- p 314 A90-49392 Lovelace Foundation for Medical Education and Research, Albuquerque, NM.
- Effects of acute hypoxia on cardiopulmonary responses to head-down tilt p 310 A90-48583

# Μ

Maryland Univ., College Park.

C-2

- Low-temperature thermal control for a lunar base [SAE PAPER 901242] p 324 A90-49312 Massachusetts Eye and Ear Infirmary, Boston.
  - The Chinchilla's vestibulo-ocular reflex
- p 307 A90-49047 Eyes open versus eyes closed - Effect on human p 318 A90-49070 rotational responses
- Massachusetts Inst. of Tech., Cambridge. The kinematics and dynamics of space manipulators -The virtual manipulator approach p 320 A90-46399 Oxidation kinetics of model compounds of metabolic
- waste in supercritical water [SAE PAPER 901333] p 328 A90-49371 Massachusetts Univ., Worcester. Non-linear analysis of visual cortical neurons
- p 315 N90-27250 [AD-A221543]

- McDonnell-Douglas Space Systems Co., Houston, TX. Space Station Environmental Health System water quality monitoring
- [SAE PAPER 901351] p 329 A90-49384
- A volatile organics concentrator for use in monitoring Space Station water quality (SAE PAPER 901352) p 329 A90-49385
- McDonnell-Douglas Space Systems Co., Huntsville, AL. Past and present environmental control and life support stems on manned spacecraft
- (SAE PAPER 901210) p 323 A90-49285 Water recovery and management test support modeling for Space Station Freedom [SAE PAPER 901214] p 323 A90-49289
- Computer aided system engineering and analysis (CASE/A) modeling package for ECLS systems - An overview
- ISAE PAPER 9012671 p 327 A90-49336 McGill Univ., Montreal (Quebec). Curvature estimation in orientation selection
- [AD-A221481] p 315 N90-27249 Michigan Univ., Ann Arbor.
- The measurement of dark adaptation level in the presence of glare
- PB90-155987] p 316 N90-28323 Mitre Corp., McLean, VA. Creature co-op: Achieving robust remote operations with
- a community of low-cost robots p 336 N90-27303

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- Naples Univ. (Italy). Effects of acute hypoxia on cardiopulmonary response p 310 A90-48583 to head-down tilt
- NASA Space Station Program Office, Reston, VA. Work/control stations in Space Station weightlessness
- p 322 A90-49278 SAE PAPER 9012031 National Aeronautics and Space Administration, Washington, DC.
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- p 316 N90-28327 [NASA-SP-7011(339)] National Aeronautics and Space Administration. Ames **Research Center, Moffett Field, CA.**
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- The Chinchilla's vestibulo-ocular reflex p 307 A90-49047
- 3-D components of a biological neural network visualized in computer generated imagery. II - Macular neural network p 307 organization A90-49049
- Influence of gravity on cat vertical vestibulo-ocular reflex p 307 A90-49053 Effect of contrast on the perceived direction of a moving
- p 317 A90-49062 plaid Human factors in the presentation of computer-generated information - Aspects of design and
- application in automated flight traffic p 321 A90-49270
- Human exercise capabilities in space p 312 A90-49276 ISAE PAPER 9012001 Manual control aspects of Space Station docking
- [SAE PAPER 901202] p 321 A90-49277
- Quality assessment of plant transpiration water p 323 A90-49301 [SAE PAPER 901230]
- Facilities for animal research in space with special reference to Space Station Freedom
- [SAE PAPER 901303] p 308 A90-49355 Research centrifuge accommodations on Space Station Freedom
- [SAE PAPER 901304] p 308 A90-49356 Scientific uses and technical implementation of a variable gravity centrifuge on Space Station Freedom [SAE PAPER 901360] p 330 A90-49393 p 330 A90-49393
- AX-5 space suit reliability model [SAE PAPER 901361] p 330 A90-49394
- A methodology for choosing candidate materials for the fabrication of planetary space suit structures p 333 A90-49430 [SAE PAPER 901429]
- A direct-interface fusible heat sink for astronaut cooling
- p 333 A90-49434 ISAE PAPER 9014331 The dynamics of orbital maneuvering: Design and evaluation of a visual display aid for human controllers p 336 N90-27767
- The effects of training on errors of perceived direction in perspective displays [NASA-TM-102792]
- p 319 N90-28329 Generation rates and chemical compositions of waste streams in a typical crewed space habitat
- [NASA-TM-102799] p 337. N90-28333

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[SAE PAPER 901379] p 330 A90-49407 National Aeronautics and Space Administration.

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Intraocular pressure, retinal vascular, and visual acuity changes during 48 hours of 10-deg head-down tilt p 310 A90-48586

Active thermal control systems for lunar and Martian ovoloration [SAE PAPER 901243] p 324 A90-49313

- Space Station Freedom CHeCS overview p 312 A90-49327 [SAE PAPER 901258]
- Space Station requirements for in-flight exercise countermeasures
- [SAE PAPER 901259] 6 312 A90-49328 Development of the Space Station Freedom Environmental Health System
- p 312 A90-49329 [SAE PAPER 901260]
- Microbiology facilities aboard Space Station Freedom (SSF) [SAE PAPER 901262] p 308 A90-49330
- Advanced air revitalization system modeling and
- testing [SAE PAPER 901332] p 328 A90-49370 Space Station Environmental Health System water
- guality monitoring [SAE PAPER 901351] p 329 A90-49384
- A volatile organics concentrator for use in monitoring Space Station water quality
- [SAE PAPER 901352] p 329 A90-49385 Recent experiences with iodine water disinfection in Shuttle
- [SAE PAPER 901356] p 329 A90-49389 Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations
- [SAE PAPER 901357] p 330 A90-49390 Heart rate and pulmonary function while wearing the launch-entry crew escape suit (LES) during + Gx acceleration and simulated Shuttle launch
- [SAE PAPER 901358] p 330 A90-49391 Computer simulation of cardiovascular changes during extended duration space flights
- [SAE PAPER 901359] p 314 A90-49392 Space Station Freedom viewed as a 'tight building' [SAF PAPER 901382] p 331 A90-49410
- Identifying atmospheric monitoring needs for Space Station Freedom [SAF PAPER 901383] p 331 A90-49411
- Space Station Freedom contamination requirements and redictions [SAF PAPER 901408]
- n 332 A90-49418 Requirements for extravehicular activities on the lunar and Martian surfaces
- [SAE PAPER 901427] p 333 A90-49428
- Design considerations for future planetary space suits SAE PAPER 901428] p 333 A90-49429 [SAE PAPER 901428]

Nuclear reaction effects in conventional risk assessment

Risk assessment methodologies for target fragments

computer-generated information - Aspects of design and

Deep-space radiation exposure analysis for solar cycle

Past and present environmental control and life support

Space Station Freedom Environmental Control and Life

Water recovery and management test support modeling for Space Station Freedom

Human subjects concerns in ground based ECLSS

testing - Managing uncertainty in closely recycled

p 311 A90-49065

p 312 A90-49066

p 321 A90-49270

p 314 A90-49381

p 323 A90-49285

p 323 A90-49286

p 323 A90-49289

p 325 A90-49320

presentation

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produced in high-energy nucleon reactions

in the

National Aeronautics and Space Administration.

Marshall Space Flight Center, Huntsville, AL.

factors

application in automated flight traffic

systems on manned spacecraft

Support System design - A status report [SAE PAPER 901211] p 3

for energetic ion exposure

Human

XXI (1975-1986)

[SAE PAPER 901347]

[SAE PAPER 901210]

[SAE PAPER 901211]

[SAE PAPER 901214]

[SAE PAPER 901251]

systems

#### CORPORATE SOURCE

Phase III Simplified Integrated Test (SIT) results - Space Station ECLSS testing

ISAE PAPER 9012521 o 325 A90-49321 Test bed design for evaluating the Space Station ECLSS Water Recovery System

ISAE PAPER 9012531 p 325 A90-49322 Facility for generating crew waste water product for

ECLSS testing [SAE PAPER 901254] p 325 A90-49323 Computer aided system engineering and analysis (CASE/A) modeling package for ECLS systems - An

overview SAE PAPER 901267 p 327 A90-49336

Rotationally actuated prosthetic helping hand [NASA-CASE-MFS-28426-1] p 334 N90-27261 Space Station Freedom ECLSS: A step toward

autonomous regenerative life support systems p 335 N90-27297 Simulation-based intelligent robotic agent for Space

Station Freedom p 335 N90-27298 Robot dynamics in reduced gravity environment p 336 N90-27333

National Aeronautics and Space Administration. Pasadena Office, CA.

Pseudomonas diagnostic assay

INASA-CASE-NPO-17653-1-CUI p 308 N90-27239 National Inst. for Occupational Safety and Health, Cincinnati, OH.

Criteria for a recommended standard: Occupational exposure to hand-arm vibration

[PB90-168048] p 337 N90-28331 Naval Health Research Center, San Diego, CA.

The integrated area measure of visual endogenous ERPs: Relation to cognitive workload and hemisphere IAD-A2231911 p 318 N90-27255 Melatonin, light and, circadian cycles

p 318 N90-27256 [AD-A223196] Naval Medical Research Inst., Bethesda, MD.

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- Naval Personnel Research and Development Center, San Diego, CA.
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[AD-A221462] p 319 N90-27258 New South Wales Univ., Kensington (Australia). A prototype computer-aided modelling tool for

life-support system models SAE PAPER 901269 p 327 A90-49337

- North Carolina Univ., Chapel Hill. A real-time optical 6D tracker for head-mounted display
- systems p 334 N90-27262 AD-A2228841
- Tracking a head-mounted display in a room-sized environment with head-mounted cameras p 335 N90-27266 [AD-A222545]

Ρ Pacific-Sierra Research Corp., Los Angeles, CA. Effects of protracted ionizing radiation dosage on

humans and animals: A brief review of selected investigations p 309 N90-27241 1AD-A2222401

Effects of ionizing radiation on the performance of elected tactical combat crews

p 315 N90-27248 AD-A2228801 Paris V Univ. (France).

Electrocardiogram of military aircraft pilots measured during real flight missions: Study of the variability of the cardiac rhythm in correlation with working stress p 316 N90-28324 IETN-90-974531

Pittsburgh Univ., PA Nystagmus responses in a group of normal humans

during earth-horizontal axis rotation p 317 A90-49046 Visual-vestibutar interaction in humans during p 317 A90-49048 earth-horizontal axis rotation

Influence of gravity on cat vertical vestibulo-ocular reflex p 307 A90-49053 Earth horizontal axis rotational responses in patients with unilateral peripheral vestibular deficits

p 318 A90-49069 Eyes open versus eyes closed - Effect on human rotational responses p 318 A90-49070

# R

Rockwell International Corp., Downey, CA. A model for a space shuttle safing and failure-detection expert o 336 N90-27314 Salk Inst. for Biological Studies, San Diego, CA. Energy-rich glyceric acid oxygen esters - Implications

- for the origin of glycolysis p 339 A90-48097 Template-directed oligomerization of 5-prime-deoxy 5-nucleosideacetic acid derivatives p 339 A90-48098
- San Jose State Univ., CA. The susceptibility of rhesus monkeys to motion ckness p 306 A90-48585 sickness
- AX-5 space suit reliability model I SAE PAPER 901361 | p 330 A90-49394
- School of Aerospace Medicine, Brooks AFB, TX. Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations
- p 330 A90-49390 SAE PAPER 901357 Heart rate and pulmonary function while wearing the launch-entry crew escape suit (LES) during + Gx acceleration and simulated Shuttle launch [SAE PAPER 901358] p 330 A90-49391
- State Univ. of New York, Plattsburgh. The effects of blast trauma (impulse noise) on hearing: A parametric study source 2
- [AD-A221731] p 316 N90-27253 Sterling Software, Moffett Field, CA.
- Manual control aspects of Space Station docking maneuvers SAE PAPER 901202 p 321 A90-49277
- A methodology for choosing candidate materials for the fabrication of planetary space suit structures

ISAE PAPER 9014291 p 333 A90-49430 Sterling Software, Palo Alto, CA.

3-D components of a biological neural network visualized in computer generated imagery. II - Macular neural network organization p 307 A90-49049 Sverdrup Technology, Inc., Bay Saint Louis, MS.

Assessment of internal contamination problems associated with bioregenerative air/water purification

[SAE PAPER 901379] p 330 A90-49407

Texas A&M Univ., College Station.

- A prototype computer-aided modelling tool for life-support system models [SAE PAPER 901269] p 327 A90-49337
- Texas Univ., Galveston.

Intraocular pressure, retinal vascular, and visual acuity changes during 48 hours of 10-deg head-down tilt

p 310 A90-48586

# U

- Universitaet der Bundeswehr Muenchen, Neubiberg (Germany, F.R.).
  - Scope and conception of the pilot support system

[LRT-WE-13-FB-88-1] p 337 N90-28334

- Vanderbilt Univ., Nashville, TN. A study on diagnosability of space station ECLSS
- p 335 N90-27294 Virginia Commonwealth Univ., Richmond.
- The relationship of isometric grip strength, optimal dynamometer settings, and certain anthropometric factors
  - p 334 N90-27264

# W

Wright State Univ., Dayton, OH.

AD-A222046

RU 24969-induced emesis in the cat - 5-HT1 sites other than 5-HT1A, 5-HT1B or 5-HT1C implicated p 307 A90-49041

# FOREIGN TECHNOLOGY INDEX

# AEROSPACE MEDICINE AND BIOLOGY / A Continuing Bibliography (Supplement 343)

December 1990

p 338 A90-48093

p 322 A90-49281

p 322 A90-49282

p 322 A90-49283

p 322 A90-49284

model, human

p 317 A90-47500

p 332 A90-49417

o 316 N90-28325

p 316 N90-28326

**FORM-GZ** 

force on vestibular

A90-49280

life support system

p 322

Selective decomposition of either enantiomer or aspartic

Miniaturization study of heat exhausting radiator of lunar

Water recycling system for CELSS environment in

Human requirements for quality life in lunar base

Ν

internal

Physiological reactions to heat stress; quantifying the

Physical characteristics of clothing materials with regard

acid irradiated with Co-60 gamma rays in the mixed

aqueous solution with D- or L-alanine

Japanese research activities of

[SAE PAPER 901205]

[SAE PAPER 901206]

[SAE PAPER 901207]

**ISAE PAPER 9012081** 

[SAE PAPER 901209]

[SAE PAPER 901390]

nystagmus in man

[IZF-1989-24]

[IZF-1989-30]

targets

to heat transport

Status of JEM ECLSS design

Internal representation.

performance model and mental workload

Hermes-crew integration aspects

Influence of gravito-inertial

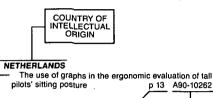
effects of individual parameters

base

space

NETHERI ANDS







Listings in this index are arranged alphabetically by country of intellectual origin. The title of the document is used to provide a brief description of the subject matter. The page number and the accession number are included in each entry to assist the user in locating the citation in the abstract section. If applicable, a report number is also included as an aid in identifying the document.

- AUSTRALIA
- A prototype computer-aided modelling tool for life-support system models
- [SAE PAPER 901269] p 327 A90-49337 AUSTRIA
- The development of the Human Waste Collection Assembly for HERMES [SAE PAPER 901287]
- n 327 A90-49347

# С

CANADA

- Curvature estimation in orientation selection [AD-A2214811 p 315 N90-27249 CZECHOSLOVAKIA
- Different effects of eubacterial and eukaryotic DNA topoisomerase II inhibitors on chloroplasts of Euglena gracilis p 306 A90-48100

## F

#### FRANCE

- Chemical structure of a prebiotic analog of adenosine p 305 A90-46654
- Chemical activity of simple basic peptides p 339 A90-48096
- Development of the suit enclosure of the European EVA oace sui
- [SAE PAPER 901244] p 324 A90-49314 Emulation of the Eva Soviet suit for neutral buoyancy simulations
- [SAE PAPER 901246] p 324 A90-49316 Water recycling in space p 325 A90-49317 [SAE PAPER 901247] Hygiene and water in Space Station
- [SAE PAPER 901386] p 331 A90-49414

Habitability studies for Hermes - A status of simulation and validation

- [SAE PAPER 901388] p 332 A90-49416 Electrocardiogram of military aircraft pilots measured during real flight missions: Study of the variability of the cardiac rhythm in correlation with working stress
- p 316 N90-28324 [ETN-90-97453] Toxicological aspects of fire onboard aircrafts: Role of the pressurization and ventilation in the cockpit

p 337 N90-28335 [ETN-90-97452]

# G

## GERMANY, FEDERAL REPUBLIC OF

- Possible amplification of enantiomer excesses through structural properties of liquid crystals - A model for origin of optical activity in the biosphere? p 338 A90-48094 The case for the chemoautotrophic origin of life in an
- A90-48099 p 339 iron-sulfur world Hormonal changes after parabolic flight - Implications on the development of motion sickness
- p 311 A90-48588
- EVA life support design advancements [SAE PAPER 901245] p 324 A90-49315 Atmosphere trace gas contamination management for
- the COLUMBUS pressurized modules [SAE PAPER 901288] p 327 A90-49348
- ECLS technology development programme Results and further activities [SAE PAPER 901289] p 327 A90-49349 Alternative hygiene concepts [SAE PAPER 901385]
- p 331 A90-49413 European Space Station health care system concept [SAE PAPER 901387] p 332 A90-49415
- IVA and EVA work place design for a man-tended (SAE PAPER 901415) p 332 A90-49423
- Common approach for planetary habitation systems implementation p 332 A90-49425
- [SAE PAPER 901417] Scope and conception of the pilot support system ASPIO [LRT-WE-13-FB-88-1] p 337 N90-28334

ł

- INTERNATIONAL ORGANIZATION Integrated air/water cooling concepts for space laboratory modules p 330 A90-49400 [SAE PAPER 901370] ISRAEL The intrinsic approach to space robotic manipulators [AIAA PAPER 90-3431] p 321 A90-47684
- ITALY Habemsi study - A study on human factors for space
  - station design [SAE PAPER 901416] p 332 A90-49424

# J

#### JAPAN

- Trajectory planning for a space manipulator [AAS PAPER 89-440] p 320 p 320 A90-46827 Dynamics and positioning control of space robot with flexible manipulators
- [AIAA PAPER 90-3397] p 320 A90-47652 A preliminary study on experimental simulation of dynamics of space manipulator system
- [AIAA PAPER 90-3399] p 321 A90-47654 Capture control for manipulator arm of free-flying space robot
- [AIAA PAPER 90-3432] p 321 A90-47685 Smart end effector for dexterous manipulation in

AIAA PAPER 90-34341 p 321 A90-47687 Abiotic synthesis of amino acids and imidazole by proton irradiation of simulated primitive earth atmospheres p 338 A90-48092

Physiological reserves of the human organism and the

- p 310 A90-46625 high-altitude environment Participation of cerebral noradrenergic structures in thermoregulation during the adaptation to cold p 306 A90-48199
- The influence of serotonine and histamine, introduced in small doses, on body temperature

p 306 A90-48200

D-1

p 337 N90-28336 [IZF-1989-10] Categorization and identification of simultaneous [IZF-1989-22] p 338 N90-28337 Calculation of clothing insulation and vapour resistance p 338 N90-28338 [IZF-1989-49] NEW ZEALAND Did membrane electrochemistry precede translation? p 305 A90-46652

# S

SOUTH AFRICA, REPUBLIC OF

Anti-LPS antibodies reduce endotoxemia in whole body Co-60 irradiated primates - A preliminary report p 306 A90-48584 SWEDEN

Report on the workshop - 'Chemical evolution and neo-abiogenesis in marine hydrothermal systems' p 305 A90-48091

# U

U,S.S.R.

Evoked potentials during periods of look fixation and periods of saccadic eye movement in humans p 309 A90-46520

Use of automated systems for the assessment of the health and the adaptive potentials of humans

p 310 A90-46521 Adaptation of trained and untrained humans to natural and technogenic extreme factors under the effect of

p 310 A90-46522 adaptogens The effect of hyperthermia on the cardiovascular system and acid-base composition of blood in dogs p 305 A90-46523

The chronic effect of an electrostatic field on certain p 305 A90-46524 biochemical indices of tissues

Stress-induced deficits of the human immune system p 310 A90-48331 Pumping equipment of autonomous inhabited systems [SAE PAPER 901250] p 325 A90-49319 UNITED KINCDOM Model-based iterative learning control of Space-Shuttle maninulator

 Inductor
 p 320
 A90-47653

 Life support
 Thoughts on the design of safety

Life support - Thoughts on the design of safety systems [SAE PAPER 901248] p 325 A90-49318 Critical technologies - Spacecraft habitability [SAE PAPER 901384] p 331 A90-49412 Accurate determination of the complex permittivity of biological tissue at 90 GHz, 70 GHz, and over a broad band around 35 GHz [AD-A222062] p 309 N90-27240

Y

YUGOSLAVIA

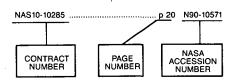
Radiation-induced polymerization in dilute aqueous solutions of cyanides p 305 A90-46655 solutions of cyanides

# **CONTRACT NUMBER INDEX**

AEROSPACE MEDICINE AND BIOLOGY / A Continuing Bibliography (Supplement 343)

December 1990

# Typical Contract Number Index Listing



Listings in this index are arranged alphanumerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under the contract are arranged in ascending order with the AIAA accession numbers appearing first. The accession number denotes the number by which the citation is identified in the abstract section. Preceding the accession number is the page number on which the citation may be found.

AF PROJ. 2312	p 309	N90-27240
	p 309	N90-28322
AF PROJ. 2313	p 315	N90-27249
	p 315	N90-27250
	p 315	N90-27251
	p 315	N90-27252
AF PROJ. 7719	p 319	N90-27257
AF-AFOSR-0247-89	p 315	N90-27250
AF-AFOSR-0260-89	p 315	N90-27249
AF-AFOSR-0302-89	p 315	N90-27252
AF-AFOSR-0304-89	p 315	N90-27251
AF-AFOSR-0321-89	p 309	N90-28322
AF-AFOSR-9343-87	p 309	N90-27240
ARPA ORDER 4864	p 317	A90-47247
A88/M/318	p 316	N90-28325
B87-62	p 316	N90-28326
B87-63	p 337	N90-28336
,	p 338	N90-28338
B88-51	p 338	N90-28337
CNES-88-5400	p 332	A90-49416
DA PROJ. RN	p 309	N90-27241
DA PROJ. 1L1-61102-B7-4A	p 314	N90-27245
DA PROJ. 3E1-62777-A-878	p 314	N90-27246
DA PROJ. 3E1-62787-A-878	p 309	N90-27242
DA PROJ. 3E1-62787-A-879	p 337	N90-28332
DA PROJ. 3M1-61102-BS-15	p 316	N90-27253
DA PROJ. 3M1-62787-A-879	p 334	N90-27263
DAMD17-86-C-6172	p 316	N90-27253
DAMD17-86-C-6260	p 309	N90-27242
DNA001-84-C-0289	p 309	N90-27241
DNA001-85-C-0352	p 315	N90-27248
DRET-84-107	p 316	N90-28324
DRET-87-1033	p 337	N90-28335
F33615-88-C-0015	p 319	N90-27259
	p 319	N90-27260
F33615-89-C-0603	p 330	A90-49391
MDA903-85-C-0460	p 311	A90-48700
MDA903-87-C-0523	p 335	N90-27267
NAGW-1197	p 331	A90-49408
NAGW-1660	p 339	A90-48098
NAG1-801	p 320	A90-46399
NAG2-155	p 307	A90-49047
,	p 307	A90-49053
NAG2-438	p 317	A90-49039
NAG8-023	p 336	N90-27331
NAG9-113	p 317	A90-49046
	p 307	A90-49047
	p 317	A90-49048 A90-49053
	p 307	
	p 318	A90-49069
	p 318	A90-49070

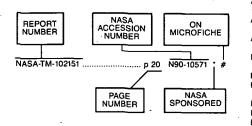
NAG9-252	p 328	A90-49371
NAG9-284	p 329	A90-49388
NAG9-375	p 310	A90-48583
NAS1-18473	p 314	N90-27244
NAS7-918	p 308	N90-27239
NCA2-IR-390-501	p 306	A90-48587
NCC-86	p 319	N90-28329
NCC2-229	p 307	A90-49041
NGT-44-001-800	p 331	A90-49411
NIH-HD-06016	p 317	A90-49039
NIH-MH-00673	p 317	A90-47247
NIH-MH-09696	p 317	A90-47247
NIH-NS-00921	p 317	A90-49046
•	p 317	A90-49048
	p 318	A90-49069
	p 318	A90-49070
NIH-NS-17585	p 307	A90-49047
	p 307	A90-49053
NIH-NS-21819	p 317	A90-49046
	p 307	A90-49047
	p 317	A90-49048
	p 307	A90-49053
	p 318	A90-49069
•	p 318	A90-49070
NIH-RR-00073	p 310	A90-48586
NIH-RR-02170	p 335	N90-27266
NIH-1-SO1-RR-033420-1	p 339	A90-48097
NSF DIR-89-03206	р 339	A90-48095
NSG-7627	p 339	A90-48097
N00014-86-K-0678	p 318	N90-27254
	D 334	N90-27265
N00014-86-K-0680	p 334	N90-27262
	p 335	N90-27266
N00014-87-K-0275	p 320	A90-46400
N00014-88-K-0086	p 334	N90-27265
N00014-89-J-1533	p 320	A90-46400
N00014-89-J-1888	D 319	N90-28328
N00039-87-C-0251	p 317	A90-47247
N66001-87-C-0079	p 311	A90-48592
324-02-00	p 314	N90-27244
506-47-11	p 319	N90-28329
591-34-31	p 337	N90-28333
001-04-01	P 007	100 20000

# **REPORT NUMBER INDEX**

AEROSPACE MEDICINE AND BIOLOGY / A Continuing Bibliography (Supplement 343)

December 1990

# Typical Report Number Index Listing



Listings in this index are arranged alphanumerically by report number. The page number indicates the page on which the citation is located. The accession number denotes the number by which the citation is identified. An asterisk (\*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche.

A-90081	p 319	N90-28329	• #
		N90-28333	
A-90099	p 337	1480-20000	TT -
		•	
AAS PAPER 89-440	p 320	A90-46827	
AD-A221462	- 010	N90-27258	4
	p 319		#
AD-A221481	p 315	N90-27249	#
AD-A221543	p 315	N90-27250	#
AD-A221544	p 315	N90-27251	#
AD-A221552	p 309	N90-27243	#
AD-A221657	p 335	N90-27267	#
AD-A221668	p 315	N90-27252	#
AD-A221709	p 319	N90-27259	#
AD-A221731	p 316	N90-27253	#
AD-A221744	p 319	N90-27260	#
AD-A221972	p 309	N90-28322	#
	p 334	N90-27264	#
		N90-27204	#
	p 309		
AD-A222240		N90-27241	#
AD-A222253	p 319	N90-27257	#
AD-A222428	p 334	N90-27265	#
AD-A222437	p 319	N90-28328	#
AD-A222454	p 309	N90-27242	#
AD-A222545	p 335	N90-27266	#
AD-A222686	·	N90-27245	#
AD-A222840	p 314	N90-27246	#
AD-A222877		N90-27247	#
AD-A222880	p 315	N90-27248	#
		N90-27248	#
	p 334		
AD-A222909		N90-27254	#
AD-A223191		N90-27255	#
AD-A223196		N90-27256	#
AD-A223226	p 334	N90-27263	#
AD-D014451	p 336	N90-28330	
,			
AFHRL-TR-89-68	p 319	N90-27257	#
AFHRL-TR-89-69		N90-27260	#
AFHRL-TR-89-70	p 319	N90-27259	#
Armic-m-03-70	p 515	1130-27233	π
	- 004	NO0 07064	#
AFIT/CI/CIA-90-020	p 334	N90-27264	#
AFOSR-90-0419TR	p 315	N90-27251	#
AFOSR-90-0422TR	p 315	N90-27249	#
AFOSR-90-0429TR	p 315	N90-27250	#
AFOSR-90-0574TR	p 309	N90-28322	#
AFOSR-90-0632TR		N90-27252	#
	•		
AIAA PAPER 90-3396	p 320	A90-47651	• #
AIAA PAPER 90-3397		A90-47652	#
		A90-47652	#
A14.4 D.4 DED 44 4444			
		A90-47654	#
AIAA PAPER 90-3431		A90-47684	#
AIAA PAPER 90-3432		A90-47685	#
AIAA PAPER 90-3434	p 321	A90-47687	#

AIP-62	p 318	N90-27254	#
ARI-TR-884	p 335	N90-27267	#
ARL-90-2	p 316	N90-27253	#
ASI690-326-89	p 335	N90-27267	#
DHHS/PUB/NIOSH-89-106	-	N90-28331	 #
DNA-TR-87-28	· ·	N90-27241	 #
DNA-TR-88-173		N90-27248	#
ETN-90-97333	p 337	N90-28334 N90-28336	#
ETN-90-97385	p 338	N90-28336	
ETN-90-97390		N90-28325	
ETN-90-97394		N90-28326	
ETN-90-97399	p 338	N90-28338	
ETN-90-97452	p 337	N90-28335	#
ETN-90-97453	p 316	N90-28324	#
HDL-TL-90-2	p 309	N90-27243	#
HEL-TN-5-90	p 314	N90-27245	#
IZF-1989-10		N90-28336	
IZF-1989-22	p 338	N90-28337	
	p 316	N90-28325	
IZF-1989-30		N90-28326	
IZF-1989-49	p 336	N90-28338	
LRT-WE-13-FB-88-1		N90-28334	#
NAS 1.15:102792		N90-28329 *	#
NAS 1.15:102799		N90-28333 *	#
NAS 1.21:7011(339)		N90-28327 *	
NAS 1.26:4281		N90-27244	#
NAS 1.71:MFS-28426-1		N90-27261 *	#
NAS 1.71:NPO-17653-1-CU	p 308	N90-27239 *	#
NASA-CASE-MFS-28426-1	p 334	N90-27261 *	#
NASA-CASE-NPO-17653-1-CU	p 308	N90-27239 *	#
NASA-CR-4281	-	N90-27244 *	#
NASA-SP-7011(339)		N90-28327 *	
NASA-TM-102792 NASA-TM-102799		N90-28329 * N90-28333 *	# #
NHRC-89-25	p 318	N90-27255	#
NHRC-89-38	p 318	N90-27256	#
NMRI-90-14	p 315	N90-27247	#
NPRDC-TN-90-18	p 319	N90-27258	#
PB90-155987 PB90-168048		N90-28323 N90-28331	# #
PCG-17		N90-27265	" #
PSR-1687		N90-27241	#
PSR-1846		N90-27248	#
SAE PAPER 901200		A90-49276 *	"
SAE PAPER 901202		A90-49277 *	
SAE PAPER 901203	p 322	A90-49278 *	
SAE PAPER 901204	p 322	A90-49279	
SAE PAPER 901205	p 322	A90-49280	
SAE PAPER 901206	p 322	A90-49281	
SAE PAPER 901207		A90-49282	
SAE PAPER 901208		A90-49283	
SAE PAPER 901209		A90-49284	
SAE PAPER 901210		A90-49285 *	
SAE PAPER 901211		A90-49286 *	
SAE PAPER 901212		A90-49287	
SAE PAPER 901213		A90-49288	
SAE PAPER 901214	p 323	A90-49289 *	

SAE PAPER 901216		p 323	A90-49291
SAE PAPER 901227		p 307	A90-49299
SAE PAPER 901228		p 307	A90-49300 *
SAE PAPER 901230		p 323	A90-49301 *
SAE PAPER 901231		p 324	A90-49302
SAE PAPER 901233 SAE PAPER 901242		р 324 р 324	A90-49303 A90-49312 *
SAE PAPER 901243		p 324	A90-49313 *
SAE PAPER 901244		p 324	A90-49314
SAE PAPER 901245 SAE PAPER 901246	•••••	p 324	A90-49315 A90-49316
SAE PAPER 901240		р 324 р 325	A90-49317
SAE PAPER 901248		p 325	A90-49318
SAE PAPER 901250	•••••	p 325	A90-49319
SAE PAPER 901251 SAE PAPER 901252		р 325 р 325	A90-49320 * A90-49321 *
SAE PAPER 901253		p 325	A90-49322 *
SAE PAPER 901254		p 325	A90-49323 *
SAE PAPER 901255 SAE PAPER 901256		p 326	A90-49324 A90-49325
SAE PAPER 901250 SAE PAPER 901257		р 326 р 326	A90-49325 A90-49326
SAE PAPER 901258		p 312	A90-49327 *
SAE PAPER 901259		p 312	A90-49328 *
SAE PAPER 901260 SAE PAPER 901262		p 312 p 308	A90-49329 * A90-49330 *
SAE PAPER 901263		p 312	A90-49331
SAE PAPER 901264		p 326	A90-49332
SAE PAPER 901265		p 326	A90-49333
SAE PAPER 901267 SAE PAPER 901268		р 327 р 326	A90-49336 * A90-49335 *
SAE PAPER 901269		p 327	A90-49337 *
SAE PAPER 901287		р 327	A90-49347
SAE PAPER 901288		p 327	A90-49348
SAE PAPER 901289 SAE PAPER 901297		р 327 р 327	A90-49349 A90-49350
SAE PAPER 901299		p 327	A90-49351
SAE PAPER 901300		p 328	A90-49352
SAE PAPER 901301	••••••	p 328	A90-49353
SAE PAPER 901302 SAE PAPER 901303		р 328 р 308	A90-49354 A90-49355 *
SAE PAPER 901304		p 308	A90-49356 *
SAE PAPER 901323		p 313	A90-49363
SAE PAPER 901324 SAE PAPER 901325	••••••	p 313 p 313	A90-49364 A90-49365
SAE PAPER 901326		p 313	A90-49366
SAE PAPER 901328	·····	p 313	A90-49367
SAE PAPER 901329	•••••	p 328	A90-49368
SAE PAPER 901331 SAE PAPER 901332		р 308 р 328	A90-49369 A90-49370 *
SAE PAPER 901333		p 328	A90-49371 *
SAE PAPER 901342	······································	p 313	A90-49377
SAE PAPER 901344 SAE PAPER 901347	••••••	p 313 p 314	A90-49379 A90-49381 *
SAE PAPER 901349		p 308	A90-49383
SAE PAPER 901351		p 329	A90-49384 *
SAE PAPER 901352		p 329	A90-49385 *
SAE PAPER 901353 SAE PAPER 901354		р 329 р 329	A90-49386 A90-49387
SAE PAPER 901355		p 329	A90-49388 *
SAE PAPER 901356		p 329	A90-49389 *
SAE PAPER 901357 SAE PAPER 901358		p 330	A90-49390 * A90-49391 *
SAE PAPER 901358		p 330 p 314	A90-49391 A90-49392 *
SAE PAPER 901360		p 330	A90-49393 *
SAE PAPER 901361		p 330	A90-49394 *
SAE PAPER 901362 SAE PAPER 901370		p 318 p 330	A90-49395 A90-49400
SAE PAPER 901379		p 330	A90-49407 *
SAE PAPER 901380		p 331	A90-49408 *
SAE PAPER 901381 SAE PAPER 901382	••••••	р 308 р 331	A90-49409 * A90-49410 *
SAE PAPER 901382 SAE PAPER 901383		p 331	A90-49411
SAE PAPER 901384		p 331	A90-49412
SAE PAPER 901385		p 331	A90-49413
SAE PAPER 901386 SAE PAPER 901387		p 331 p 332	A90-49414 A90-49415
SAE PAPER 901388		p-332	A90-49416
SAE PAPER 901390		p 332	A90-49417
SAE PAPER 901408		p 332	A90-49418 * A90-49423
SAE PAPER 901415 SAE PAPER 901416		p 332 p 332	A90-49423 A90-49424
SAE PAPER 901417		p 332	A90-49425
SAE PAPER 901418		p 333	A90-49426

# SAE PAPER 901427

SAE PAPER 901427	. p 333	A90-49428 *	
SAE PAPER 901428	. p 333	A90-49429 *	
SAE PAPER 901429	. p 333	A90-49430 *	
SAE PAPER 901432	. p 333	A90-49433 *	
SAE PAPER 901433	p 333	A90-49434 *	
TD-89-1056	. p 316	N90-28326	
TD-89-1644	p 337	N90-28336	
TD-89-3365	p 338	N90-28337	
TD-89-3367	p 316	N90-28325	
TD-89-4547	p 338	N90-28338	
TR-2107	p 314	N90-27244 * #	¥
•			
TR90-011	p 334	N90-27262 #	¥
UMTRI-89-34	p 316	N90-28323 #	¥
	p 336	N90-28330	
	p 308	N90-27239 * #	¥
US-PATENT-APPL-SN-508154	p 334	N90-27261 * #	ŧ
	•		
US-PATENT-CLASS-73-37	p 336	N90-28330	
US-PATENT-4,885,930	p 336	N90-28330	
USAARL-89-12	p 337	N90-28332 #	
USAARL-90-10	p 334	N90-27263 #	ŧ
USAFSAM-TR-89-20	p 309	N90-27240 #	ŧ

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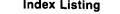
F-2

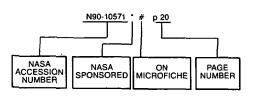
# **ACCESSION NUMBER INDEX**

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December 1990

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Listings in this index are arranged alphanumerically by accession number. The page number listed to the right indicates the page on which the citation is located. An asterisk (\*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche.

A90-46399	p 320	A90-49066 *	p 312
A90-46400	p 320	A90-49069 *	p 318
A90-46520	p 309	A90-49070 *	p 318
A90-46521	p 310	A90-49270 * #	p 321
A90-46522	p 310	A90-49276 *	p 312
A90-46523	p 305	A90-49277 *	
A90-46524	р 305	A90-49277 *	p 321 p 322
A90-46625	p 310	A90-49278 A90-49279	p 322 p 322
A90-46652	p 305	A90-49280	p 322 p 322
A90-46654	p 305	A90-49281	p 322
A90-46655	p 305	A90-49282	p 322
A90-46827	p 320	A90-49283	p 322
A90-47247	p 317	A90-49284	p 322
A90-47500	p 317	A90-49285 *	p 323
A90-47651 * #	p 320	A90-49286 *	p 323
A90-47652 #	p 320	A90-49287	p 323
A90-47653 #	p 320	A90-49288	p 323
A90-47654 # A90-47684 #	р 321 р 321	A90-49289 *	p 323
A00 47695 #		A90-49291	p 323
A90-47685 # A90-47687 #	p 321 p 321	A90-49299	p 307
A90-48091	p 305	A90-49300 *	p 307
A90-48092	p 338	A90-49301 *	p 323
A90-48093	μ 338 · μ 338	A90-49302	p 324
	p 338	A90-49303	p 324
A90-48095	p 339	A90-49312 *	p 324
A90-48096	p 339	A90-49313 *	p 324
A90-48097 *	p 339	A90-49314	p 324
A90-48098 *	p 339	A90-49315	p 324
A90-48099	p 339	A90-49316	p 324
A90-48100	p 306	A90-49317	p 325
A90-48101 *	p 339	A90-49318	p 325
A90-48199	p 306	A90-49319	p 325
A90-48200	p 306	A90-49320 *	p 325
A90-48331	p 310	A90-49321 *	p 325
A90-48583 *	p 310	A90-49322 *	p 325
A90-48584	p 306	A90-49323 *	p 325
A90-48585 ·	p 306	A90-49324	p 326
A90-48586 *	p 310	A90-49325	p 326
A90-48587 *	p 306	A90-49326	p 326
A90-48588	p 311	A90-49327 *	p 312
A90-48589	p 311	A90-49328 *	p 312
A90-48590	p 311	A90-49329 *	p 312
A90-48591	p 311	A90-49330 *	p 308
A90-48592	p 311	A90-49331	p 312
A90-48700	p 311	A90-49332	p 326
A90-49039 *	p 317	A90-49333	p 326
A90-49041 *	p 307	A90-49335 *	p 326
A90-49046 *	p 317	A90-49336 *	p 327
A90-49047 ·	p 307	A90-49337	p 327
A90-49048 *	p 317	A90-49347	p 327
A90-49049 ·	p 307	A90-49348	p 327
A90-49053 *	p 307	A90-49349	p 327
A90-49062 *	•	A90-49350	p 327
-	p 317	A90-49351	p 327
A90-49065 ·	p 311 -	A90-49352	p 328

A90.49353         A90.49355         A90.49355         A90.49363         A90.49363         A90.49363         A90.49364         A90.49365         A90.49366         A90.49367         A90.49367         A90.49367         A90.49367         A90.49367         A90.49368         A90.49377         A90.49377         A90.49377         A90.49383         A90.49384         A90.49385         A90.49388         A90.49388         A90.49389         A90.49389         A90.49389         A90.49390         A90.49391         A90.49389         A90.49388         A90.49390         A90.49391         A90.49392         A90.49393         A90.49410         A90.49411	p 328  p 308  p 308  p 308  p 313  p 313  p 313  p 313  p 313  p 313  p 328  p 329  p 330  p 3314  p 330  p 3314  p 330  p 3318  p 331  p 332  p 333
N90-27239         #           N90-27240         #           N90-27241         #           N90-27242         #           N90-27243         #           N90-27244         #           N90-27245         #           N90-27246         #           N90-27247         #           N90-27248         #           N90-27250         #           N90-27252         #           N90-27252         #           N90-27253         #           N90-27254         #           N90-27255         #           N90-27256         #           N90-27257         #           N90-27258         #           N90-27261         #           N90-27262         #           N90-27263         #           N90-27264         #           N90-27265         #           N90-27266         #           N90-2726	$ p 308  p 309  p 309  p 309  p 309  p 314  p 314  p 314  p 315  p 316  p 318  p 318  p 319  p 319  p 334  p 334  p 334  p 334  p 335  p 335  p 335 \\ p 35 \\ $

00-27298 * # 00-27303 * # 00-27311 * # 00-27314 * # 00-27331 * # 00-27333 * # 00-27337 * # 00-28322 # 00-28323 #	p 335 p 336 p 336 p 336 p 336 p 336 p 336 p 336
90-27311 * # 90-27314 * # 90-27331 * # 90-27333 * # 90-27767 * # 90-28322 #	p 336 p 336 p 336 p 336 p 336 p 336
90-27314 * # 90-27331 * # 90-27333 * # 90-27767 * # 90-28322 #	p 336 p 336 p 336 p 336
90-27331 * # 90-27333 * # 90-27767 * # 90-28322 #	р 336 р 336 р 336
90-27333 * # 90-27767 * # 90-28322 #	р 336 р 336
90-27767 *# 90-28322 #	p 336
90-28322 #	
	- 000
10-28323 #	p 309
	p 316
0-28324 #	p 316
0-28325	p 316
0-28326	p 316
0-28327 *	p 316
90-28328 #	p 319
0-28329 *#	p 319
0-28330	p 336
90-28331 #	p 337
90-28332 #	p 337
0-28333 * #	p 337
0-28334 #	p 337
0-28335 #	p 337
0-28336	p 337
0-28337	p 338
0-28338	p 338
00-28333 * # 10-28334 # 10-28335 # 10-28336	

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