NASA

Aerospace Medicine and Biology
A Continuing Bibliography with Indexes

NASA SP-7011 (343)
December 1990

National Aeronautics and Space Administration

Aerospace Medicine & Biology
space Medicine & Biology Aero
e Medicine & Biology Aerospac
dicine & Biology Aerospace Me
ne & Biology Aerospace Medic
Biology Aerospace Medicine &
gy Aerospace Medicine & Biol
erospace Medicine & Biology A
pace Medicine & Biology Aeros
Medicine & Biology Aerospace
cine & Biology Aerospace Med
& Biology Aerospace Medicine

Aerospace Medicine and Biology

ACCESSION NUMBER RANGES

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

STAR (N-10000 Series)	N90-26790 — N90-28488
IAA (A-10000 Series)	A90-45845 — A90-49869

This bibliography was prepared by the NASA Scientific and Technical Information Facility operated for the National Aeronautics and Space Administration by RMS Associates.

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

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

INTRODUCTION

This Supplement to *Aerospace Medicine and Biology* lists 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.

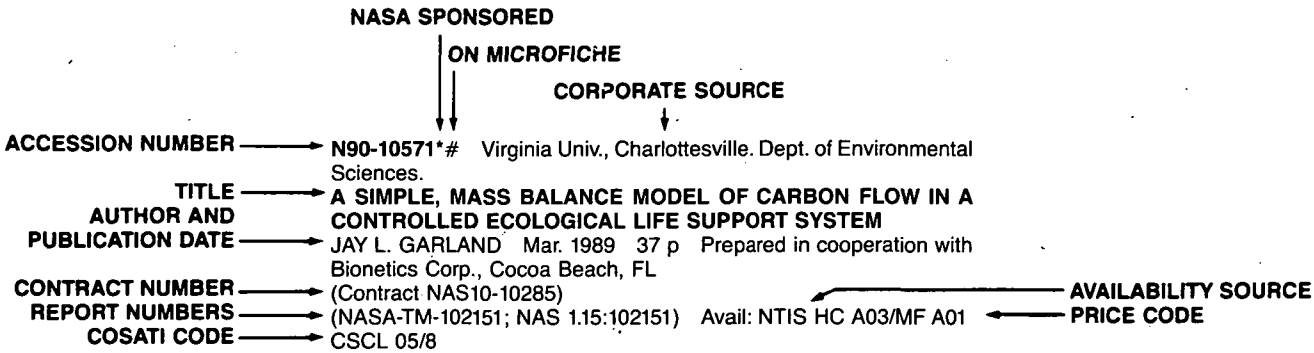
Seven indexes — subject, personal author, corporate source, foreign technology, contract, report number, and accession number — are included.

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

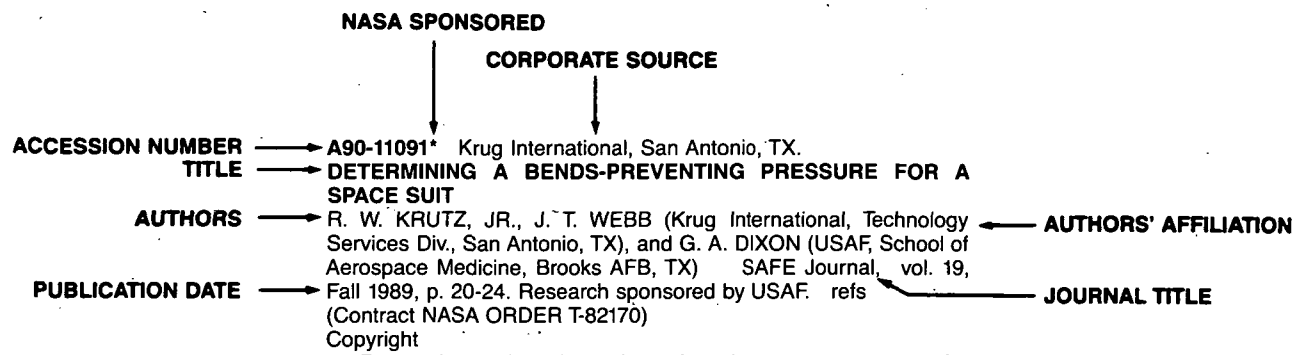
TYPICAL REPORT CITATION AND ABSTRACT



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

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT



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.

AEROSPACE MEDICINE AND BIOLOGY

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

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

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

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

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

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. Author

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)
Copyright

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 of the tibia. Male tibiae changed primarily in structural 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. L.K.S.

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 Brain Research (ISSN 0014-4819), vol. 69, 1988, p. 307-314. refs
(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. O.C.

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 detection

of 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 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
Copyright

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. I.S.

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. I.S.

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
Copyright

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 subjects to extreme conditions. I.S.

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. I.S.

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)
Copyright

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)
Copyright

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

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

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. L.K.S.

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

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

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

This article reviews positive pressure breathing's (PPB's) background and present use as protection against +Gz 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)

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)

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

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). C.D.

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 an operational level of fitness to ensure mission success. Author

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

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
DEBRA L. KRUPA (Krug International Corp., Houston, TX) SAE, 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. B.P.

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, 20th, Williamsburg, VA, July 9-12, 1990. 12 p.
(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

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/sq 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 missions. Author

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 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

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

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

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 tube. GRA

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. ESA

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. ESA

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. ESA

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)
Copyright

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. Author

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
Copyright

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. Author

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 NIH-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 system. Author

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 quality 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 42 p Submitted for 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 p 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

N90-28329*# National Aeronautics and Space Administration. 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 SUPPORT

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)
Copyright

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. Author

A90-46400
THREE-DIMENSIONAL CAMERA SPACE MANIPULATION
S. B. SKAAR, W. H. BROCKMAN, and W. S. JANG (Iowa 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

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

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 and Astronautics, 1990, p. 1050-1055. refs
(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
HIRONORI FUJII, TSUTOMU MURAYAMA, 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

A90-49270*# National Aeronautics and Space Administration. 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, VA) Ortung und Navigation (ISSN 0474-7550), no. 1, 1990, p. 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 decreasing 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. O.C.

A90-49279
DESIGNING SPACE HABITATS FOR HUMAN PRODUCTIVITY
MARC M. COHEN (Michigan, University, Ann Arbor) SAE, Intersociety Conference on Environmental Systems, 20th, 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
NAOAKI IZUTANI, TADASHI OGURA, and HIROYASU 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

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. Author

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. Author

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. V.T.

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

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 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. R.E.P.

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. Author

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. Author

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. Author

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. Author

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. L.K.S.

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. Author

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. R.E.P.

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 Raumfahrt- und 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. Author

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 Germany) SAE, Intersociety Conference on Environmental 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
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) SAE, 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) SAE, 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

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 separation of volatiles from the water phase. Seven options 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. Author

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 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. L.K.S.

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. Author

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. L.K.S.

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 exfoliated 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. Author

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 human-performance aspects are discussed, and emphasis is placed on human-system, human-machine, and human-computer 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. V.T.

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, TX) 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 attached payloads. Author

A90-49423
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

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. V.T.

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. V.T.

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 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. V.T.

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 prototpye 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. Author

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 are pivotally mounted on a housing that it secured to the amputee's 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 with the lower arm, the amputee can open and close 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) Avail: 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.
RULE 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 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
WILLIAM S. DAVIS *In* NASA, Marshall Space Flight Center, 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

N90-27298*# National Aeronautics and Space Administration. 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 orbiter. SAFE, whose knowledge was extracted 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 p
(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. Author

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. Author

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

N90-28337 Institute for Perception RVO-TNO, Soesterberg (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 sq 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 biomolecules in the primordial earth are indicated. T.K.

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)

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. Author

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

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 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)

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)

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

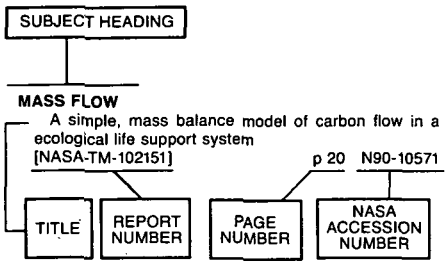
The possibility that the first microorganisms on earth may have been chemoautotrophic (i.e., capable of synthesizing their own carbon compounds from CO2 or other C1 units) rather than heterotrophic (requiring an external source of C compounds) is considered theoretically. Particular attention is given 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 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

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

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

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.

A

B

C

D

E

F

G

H

I

J

L

M

N

O

P

R

S

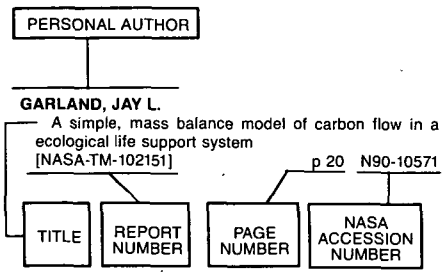
T

U

V

W

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.

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

R

S

T

U

V

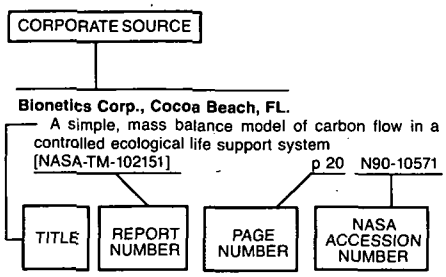
W

Y

Z

CORPORATE SOURCE INDEX

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.

A

B

C

D

E

G

H

I

J

SOURCE

K

L

M

N

P

R

S

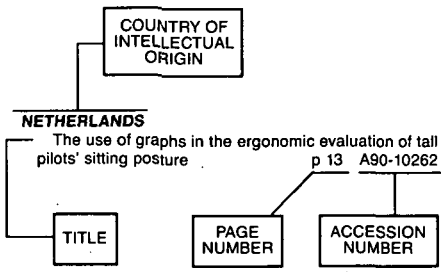
T

U

V

W

Typical Foreign Technology Index Listing

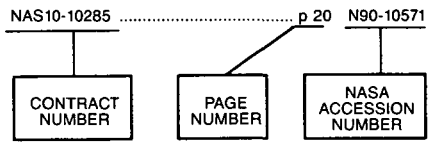


Listings in this index are arranged alphabetically by country of intellectual origin. The title of the document is used to provide a brief description of the subject matter. The page number and the accession number are included in each entry to assist the user in locating the citation in the abstract section. If applicable, a report number is also included as an aid in identifying the document.

FOREIGN

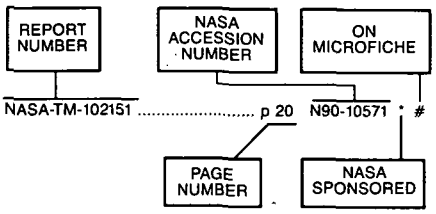
Y

Typical Contract Number Index Listing



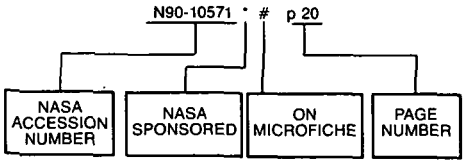
Listings in this index are arranged alphanumerically by contract number. Under each contract number, the accession numbers denoting documents that have been produced as a result of research done under the contract are arranged in ascending order with the AIAA accession numbers appearing first. The accession 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.

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.

Typical Accession Number Index Listing



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.

AVAILABILITY OF CITED PUBLICATIONS

IAA ENTRIES (A90-10000 Series)

Publications announced in *IAA* are available from the AIAA Technical Information Service as follows: Paper copies of accessions are available at $10.00 per document (up to 50 pages), additional pages $0.25 each. Microfiche[1] of documents announced in *IAA* are available at the rate of $4.00 per microfiche on demand. Standing order microfiche are available at the rate of $1.45 per microfiche for *IAA* source documents and $1.75 per microfiche for AIAA meeting papers.

Minimum air-mail postage to foreign countries is $2.50. All foreign orders are shipped on payment of pro-forma invoices.

All inquiries and requests should be addressed to: Technical Information Service, American Institute of Aeronautics and Astronautics, 555 West 57th Street, New York, NY 10019. Please refer to the accession number when requesting publications.

STAR ENTRIES (N90-10000 Series)

One or more sources from which a document announced in *STAR* is available to the public is ordinarily given on the last line of the citation. The most commonly indicated sources and their acronyms or abbreviations are listed below. If the publication is available from a source other than those listed, the publisher and his address will be displayed on the availability line or in combination with the corporate source line.

Avail: NTIS. Sold by the National Technical Information Service. Prices for hard copy (HC) and microfiche (MF) are indicated by a price code preceded by the letters HC or MF in the *STAR* citation. Current values for the price codes are given in the tables on NTIS PRICE SCHEDULES.

Documents on microfiche are designated by a pound sign (#) following the accession number. The pound sign is used without regard to the source or quality of the microfiche.

Initially distributed microfiche under the NTIS SRIM (Selected Research in Microfiche) is available at greatly reduced unit prices. For this service and for information concerning subscription to NASA printed reports, consult the NTIS Subscription Section, Springfield, VA 22161.

NOTE ON ORDERING DOCUMENTS: When ordering NASA publications (those followed by the * symbol), use the N accession number. NASA patent applications (only the specifications are offered) should be ordered by the US-Patent-Appl-SN number. Non-NASA publications (no asterisk) should be ordered by the AD, PB, or other *report number* shown on the last line of the citation, not by the N accession number. It is also advisable to cite the title and other bibliographic identification.

Avail: SOD (or GPO). Sold by the Superintendent of Documents, U.S. Government Printing Office, in hard copy. The current price and order number are given following the availability line. (NTIS will fill microfiche requests, as indicated above, for those documents identified by a # symbol.)

(1) A microfiche is a transparent sheet of film, 105 by 148 mm in size containing as many as 60 to 98 pages of information reduced to micro images (not to exceed 26.1 reduction).

Avail: BLL (formerly NLL): British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England. Photocopies available from this organization at the price shown. (If none is given, inquiry should be addressed to the BLL.)

Avail: DOE Depository Libraries. Organizations in U.S. cities and abroad that maintain collections of Department of Energy reports, usually in microfiche form, are listed in *Energy Research Abstracts.* Services available from the DOE and its depositories are described in a booklet, *DOE Technical Information Center - Its Functions and Services* (TID-4660), which may be obtained without charge from the DOE Technical Information Center.

Avail: ESDU. Pricing information on specific data, computer programs, and details on Engineering Sciences Data Unit (ESDU) topic categories can be obtained from ESDU International Ltd. Requesters in North America should use the Virginia address while all other requesters should use the London address, both of which are on the page titled ADDRESSES OF ORGANIZATIONS.

Avail: Fachinformationszentrum, Karlsruhe. Sold by the Fachinformationszentrum Energie, Physik, Mathematik GMBH, Eggenstein Leopoldshafen, Federal Republic of Germany, at the price shown in deutschmarks (DM).

Avail: HMSO. Publications of Her Majesty's Stationery Office are sold in the U.S. by Pendragon House, Inc. (PHI), Redwood City, CA. The U.S. price (including a service and mailing charge) is given, or a conversion table may be obtained from PHI.

Avail: NASA Public Document Rooms. Documents so indicated may be examined at or purchased from the National Aeronautics and Space Administration, Public Documents Room (Room 126), 600 Independence Ave., S.W., Washington, DC 20546, or public document rooms located at each of the NASA research centers, the NASA Space Technology Laboratories, and the NASA Pasadena Office at the Jet Propulsion Laboratory.

Avail: Univ. Microfilms. Documents so indicated are dissertations selected from *Dissertation Abstracts* and are sold by University Microfilms as xerographic copy (HC) and microfilm. All requests should cite the author and the Order Number as they appear in the citation.

Avail: US Patent and Trademark Office. Sold by Commissioner of Patents and Trademarks, U.S. Patent and Trademark Office, at the standard price of $1.50 each, postage free.

Avail: (US Sales Only). These foreign documents are available to users within the United States from the National Technical Information Service (NTIS). They are available to users outside the United States through the International Nuclear Information Service (INIS) representative in their country, or by applying directly to the issuing organization.

Avail: USGS. Originals of many reports from the U.S. Geological Survey, which may contain color illustrations, or otherwise may not have the quality of illustrations preserved in the microfiche or facsimile reproduction, may be examined by the public at the libraries of the USGS field offices whose addresses are listed in this Introduction. The libraries may be queried concerning the availability of specific documents and the possible utilization of local copying services, such as color reproduction.

Avail: Issuing Activity, or Corporate Author, or no indication of availability. Inquiries as to the availability of these documents should be addressed to the organization shown in the citation as the corporate author of the document.

PUBLIC COLLECTIONS OF NASA DOCUMENTS

DOMESTIC: NASA and NASA-sponsored documents and a large number of aerospace publications are available to the public for reference purposes at the library maintained by the American Institute of Aeronautics and Astronautics, Technical Information Service, 555 West 57th Street, 12th Floor, New York, NY 10019.

EUROPEAN: An extensive collection of NASA and NASA-sponsored publications is maintained by the British Library Lending Division, Boston Spa, Wetherby, Yorkshire, England for public access. The British Library Lending Division also has available many of the non-NASA publications cited in *STAR*. European requesters may purchase facsimile copy or microfiche of NASA and NASA-sponsored documents, those identified by both the symbols # and * from ESA – Information Retrieval Service European Space Agency, 8-10 rue Mario-Nikis, 75738 CEDEX 15, France.

FEDERAL DEPOSITORY LIBRARY PROGRAM

In order to provide the general public with greater access to U.S. Government publications, Congress established the Federal Depository Library Program under the Government Printing Office (GPO), with 51 regional depositories responsible for permanent retention of material, inter-library loan, and reference services. At least one copy of nearly every NASA and NASA-sponsored publication, either in printed or microfiche format, is received and retained by the 51 regional depositories. A list of the regional GPO libraries, arranged alphabetically by state, appears on the inside back cover. These libraries are *not* sales outlets. A local library can contact a Regional Depository to help locate specific reports, or direct contact may be made by an individual.

STANDING ORDER SUBSCRIPTIONS

NASA SP-7011 and its supplements are available from the National Technical Information Service (NTIS) on standing order subscription as PB90-912300 at the price of $11.50 domestic and $23.00 foreign, and at $19.50 domestic and $39.00 foreign for the annual index. Standing order subscriptions do not terminate at the end of a year, as do regular subscriptions, but continue indefinitely unless specifically terminated by the subscriber. Questions on the availability of the predecessor publications, *Aerospace Medicine and Biology* (Volumes I-XI), should be directed to NTIS.

ADDRESSES OF ORGANIZATIONS

American Institute of Aeronautics and Astronautics
Technical Information Service
555 West 57th Street, 12th Floor
New York, New York 10019

British Library Lending Division,
Boston Spa, Wetherby, Yorkshire,
England

Commissioner of Patents and Trademarks
U.S. Patent and Trademark Office
Washington, DC 20231

Department of Energy
Technical Information Center
P.O. Box 62
Oak Ridge, Tennessee 37830

European Space Agency-Information Retrieval Service
ESRIN
Via Galileo Galilei
00044 Frascati (Rome) Italy

Engineering Sciences Data Unit International
P.O. Box 1633
Manassas, Virginia 22110

Engineering Sciences Data Unit International, Ltd.
251-259 Regent Street
London, W1R 7AD, England

Fachinformationszentrum Energie, Physik, Mathematik
GMBH
7514 Eggenstein Leopoldshafen
Federal Republic of Germany

Her Majesty's Stationery Office
P.O. Box 569, S.E. 1
London, England

NASA Scientific and Technical Information Facility
P.O. Box 8757
BWI Airport, Maryland 21240

National Aeronautics and Space Administration
Scientific and Technical Information Division (NTT)
Washington, DC 20546

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

Pendragon House, Inc.
899 Broadway Avenue
Redwood City, California 94063

Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402

University Microfilms
A Xerox Company
300 North Zeeb Road
Ann Arbor, Michigan 48106

University Microfilms, Ltd.
Tylers Green
London, England

U.S. Geological Survey Library National Center
MS 950
12201 Sunrise Valley Drive
Reston, Virginia 22092

U.S. Geological Survey Library
2255 North Gemini Drive
Flagstaff, Arizona 86001

U.S. Geological Survey
345 Middlefield Road
Menlo Park, California 94025

U.S. Geological Survey Library
Box 25046
Denver Federal Center, MS914
Denver, Colorado 80225

NTIS PRICE SCHEDULES

(Effective January 1, 1990)

Schedule A
STANDARD PRICE DOCUMENTS AND MICROFICHE

PRICE CODE	NORTH AMERICAN PRICE	FOREIGN PRICE
A01	$ 8.00	$ 16.00
A02	11.00	22.00
A03	15.00	30.00
A04-A05	17.00	34.00
A06-A09	23.00	46.00
A10-A13	31.00	62.00
A14-A17	39.00	78.00
A18-A21	45.00	90.00
A22-A25	53.00	106.00
A99	*	*
N01	60.00	120.00
N02	59.00	118.00
N03	20.00	40.00

Schedule E
EXCEPTION PRICE DOCUMENTS AND MICROFICHE

PRICE CODE	NORTH AMERICAN PRICE	FOREIGN PRICE
E01	$10.00	$ 20.00
E02	12.00	24.00
E03	14.00	28.00
E04	16.50	33.00
E05	18.50	37.00
E06	21.50	43.00
E07	24.00	48.00
E08	27.00	54.00
E09	29.50	59.00
E10	32.50	65.00
E11	35.00	70.00
E12	38.50	77.00
E13	41.00	82.00
E14	45.00	90.00
E15	48.50	97.00
E16	53.00	106.00
E17	57.50	115.00
E18	62.00	124.00
E19	69.00	138.00
E20	80.00	160.00
E99	*	*

** Contact NTIS for price quote.*

IMPORTANT NOTICE

NTIS Shipping and Handling Charges

U.S., Canada, Mexico — ADD $3.00 per TOTAL ORDER

All Other Countries — ADD $4.00 per TOTAL ORDER

Exceptions — Does NOT apply to:

ORDERS REQUESTING NTIS RUSH HANDLING

ORDERS FOR SUBSCRIPTION OR STANDING ORDER PRODUCTS *ONLY*

NOTE: Each additional delivery address on an order requires a separate shipping and handling charge.

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA SP-7011(343)		

4. Title and Subtitle	5. Report Date
Aerospace Medicine and Biology A Continuing Bibliography (Supplement 343)	December 1990
	6. Performing Organization Code NTT
7. Author(s)	8. Performing Organization Report No.
	10. Work Unit No.
9. Performing Organization Name and Address NASA Scientific and Technical Information Division	11. Contract or Grant No.
	13. Type of Report and Period Covered Special Publication
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, DC 20546	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This bibliography lists 217 reports, articles and other documents introduced into the NASA scientific and technical information system in November 1990.

17. Key Words (Suggested by Authors(s))	18. Distribution Statement
Aerospace Medicine Bibliographies Biological Effects	Unclassified - Unlimited Subject Category - 52

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price *
Unclassified	Unclassified	82	A05/HC

*For sale by the National Technical Information Service, Springfield, Virginia 22161

NASA-Langley, 1990

FEDERAL REGIONAL DEPOSITORY LIBRARIES

ALABAMA

AUBURN UNIV. AT MONTGOMERY LIBRARY
Documents Department
Montgomery, AL 36193
(205) 279-9110 ext.253

UNIV. OF ALABAMA LIBRARY
Reference Department/Documents
Box S
Tuscaloosa, AL 35486
(205) 348-6046

ARIZONA

DEPT. OF LIBRARY, ARCHIVES, AND PUBLIC RECORDS
Third Floor State Capitol
1700 West Washington
Phoenix, AZ 85007
(602) 255-4121

ARKANSAS

ARKANSAS STATE LIBRARY
Documents Service Section
One Capitol Mall
Little Rock, AR 72201
(501) 371-2090

CALIFORNIA

CALIFORNIA STATE LIBRARY
Govt. Publications Section
914 Capitol Mall
Sacramento, CA 95814
(916) 322-4572

COLORADO

UNIV. OF COLORADO
Norlin Library
Government Publications Division
Campus Box 184
Boulder, CO 80309
(303) 492-8834

DENVER PUBLIC LIBRARY
Govt. Pub. Department
1357 Broadway
Denver, CO 80203
(303) 571-2346

CONNECTICUT

CONNECTICUT STATE LIBRARY
231 Capitol Avenue
Hartford, CT 06106
(203) 566-4971

FLORIDA

UNIV. OF FLORIDA LIBRARIES
Documents Department
Library West
Gainesville, FL 32611
(904) 392-0367

GEORGIA

UNIV. OF GEORGIA LIBRARIES
Government Documents Dept.
Athens, GA 30602
(404) 542-8949

HAWAII

UNIV. OF HAWAII
Hamilton Library
Government Documents Collection
2550 The Mall
Honolulu, HI 96822
(808) 948-8230

IDAHO

UNIV. OF IDAHO LIBRARY
Documents Section
Moscow, ID 83843
(208) 885-6344

ILLINOIS

ILLINOIS STATE LIBRARY
Federal Documents
Centennial Building
Springfield, IL 62756
(217) 782-5012

INDIANA

INDIANA STATE LIBRARY
Serials Section
140 North Senate Avenue
Indianapolis, IN 46204
(317) 232-3686

IOWA

UNIV. OF IOWA LIBRARIES
Government Publications Dept.
Iowa City, IA 52242
(319) 335-5926

KANSAS

UNIVERSITY OF KANSAS
Spencer Research Library
Government Documents
Lawrence, KS 66045
(913) 864-4662

KENTUCKY

UNIV. OF KENTUCKY LIBRARIES
Government Publications/Maps Dept.
Lexington, KY 40506
(606) 257-8400

LOUISIANA

LOUISIANA STATE UNIVERSITY
Middleton Library
Government Documents Dept.
Baton Rouge, LA 70803
(504) 388-2570

LOUISIANA TECHNICAL UNIV.
Prescott Memorial Library
Government Documents Dept.
Ruston, LA 71272
(318) 257-4962

MAINE

UNIVERSITY OF MAINE
Raymond H. Fogler Library
Govt. Documents & Microforms Dept.
Orono, ME 04469
(207) 581-1680

MARYLAND

UNIVERSITY OF MARYLAND
McKeldin Library
Documents/Maps Room
College Park, MD 20742
(301) 454-3034

MASSACHUSETTS

BOSTON PUBLIC LIBRARY
Government Documents Dept.
666 Boylston Street
Boston, MA 02117
(617) 536-5400 ext.226

MICHIGAN

DETROIT PUBLIC LIBRARY
5201 Woodward Avenue
Detroit, MI 48202
(313) 833-1409

LIBRARY OF MICHIGAN
Government Documents
P.O. Box 30007
735 E. Michigan Avenue
Lansing, MI 48909
(517) 373-1593

MINNESOTA

UNIVERSITY OF MINNESOTA
Wilson Library
Government Publications
309 Nineteenth Avenue South
Minneapolis, MN 55455
(612) 373-7813

MISSISSIPPI

UNIV. OF MISSISSIPPI LIB.
Government Documents Dept.
106 Old Gym Bldg.
University, MS 38677
(601) 232-5857

MISSOURI

University of Missouri at Columbia Library
Government Documents
Columbia, MO 65201
(314) 882-6733

MONTANA

UNIV. OF MONTANA
Mansfield Library
Documents Division
Missoula, MT 59812
(406) 243-6700

NEBRASKA

UNIVERSITY OF NEBRASKA - LINCOLN
Love Memorial Library
Documents Department
Lincoln, NE 68588
(402) 472-2562

NEVADA

UNIV. OF NEVADA-RENO LIB.
Govt. Pub. Department
Reno, NV 89557
(702) 784-6579

NEW JERSEY

NEWARK PUBLIC LIBRARY
U.S. Documents Division
5 Washington Street
P.O. Box 630
Newark, NJ 07101
(201) 733-7812

NEW MEXICO

UNIVERSITY OF NEW MEXICO
General Library
Government Publications/Maps Dept.
Albuquerque, NM 87131
(505) 277-5441

NEW MEXICO STATE LIBRARY
325 Don Gaspar Avenue
Santa Fe, NM 87501
(505) 827-3826

NEW YORK

NEW YORK STATE LIBRARY
Documents Sect. Cultural Educ. Ctr.
Empire State Plaza
Albany, NY 12230
(518) 474-5563

NORTH CAROLINA

UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL
Davis Library 080A
BA/SS Department Documents
Chapel Hill, NC 27514
(919) 962-1151

NORTH DAKOTA

NORTH DAKOTA STATE UNIVERSITY LIBRARY
Government Documents Dept.
Fargo, ND 58105
(701) 237-8352
In cooperation with Univ. of North Dakota, Chester Fritz Library
Grand Forks

OHIO

STATE LIBRARY OF OHIO
Documents Section
65 South Front Street
Columbus, OH 43266
(614) 644-7051

OKLAHOMA

OKLAHOMA DEPT. OF LIBRARIES
Government Documents
200 NE 18th Street
Oklahoma City, OK 73105
(405) 521-2502, ext. 252

OKLAHOMA STATE UNIV. LIB.
Documents Department
Stillwater, OK 74078
(405) 624-0489

OREGON

PORTLAND STATE UNIV.
Millar Library
934 SW Harrison - P.O. Box 1151
Portland, OR 97207
(503) 229-3673

PENNSYLVANIA

STATE LIBRARY OF PENN.
Government Publications Section
Box 1601
Walnut St. & Commonwealth Ave.
Harrisburg, PA 17105
(717) 787-3752

SOUTH CAROLINA

CLEMSON UNIV. COOPER LIB.
Documents Department
Clemson, SC 29634
(803) 656-5174
In cooperation with Univ. of South Carolina, Thomas Cooper Library, Columbia

TEXAS

TEXAS STATE LIBRARY
Public Services Department
P.O. Box 12927 - 1201 Brazos
Austin, TX 78711
(512) 463-5455

TEXAS TECH. UNIV. LIBRARY
Documents Department
Lubbock, TX 79409
(806) 742-2268

UTAH

UTAH STATE UNIVERSITY
Merrill Library & Learning Resources Center, UMC-30
Documents Department
Logan, UT 84322
(801) 750-2682

VIRGINIA

UNIVERSITY OF VIRGINIA
Alderman Library
Government Documents
Charlottesville, VA 22903
(804) 924-3133

WASHINGTON

WASHINGTON STATE LIBRARY
Document Section
Olympia, WA 98504
(206) 753-4027

WEST VIRGINIA

WEST VIRGINIA UNIV. LIB.
Government Documents Section
P.O. Box 6069
Morgantown, WV 26506
(304) 293-3640

WISCONSIN

ST. HIST SOC. OF WISCONSIN LIB.
Government Pub. Section
816 State Street
Madison, WI 53706
(608) 262-2781
In cooperation with Univ. of Wisconsin-Madison, Memorial Library

MILWAUKEE PUBLIC LIBRARY
Documents Division
814 West Wisconsin Avenue
Milwaukee, WI 53233
(414) 278-3065

WYOMING

WYOMING STATE LIBRARY
Supreme Court & Library Bldg.
Cheyenne, WY 82002
(307) 777-5919

National Aeronautics and
Space Administration
Code NTT-4

Washington, D.C.
20546-0001