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September 1993

P-106

AEROSPACE MEDICINE AND BIOLOGY

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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AEROSPACE MEDICINE AND BIOLOGY

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National Aeronautics and Space Administration
Scientific and Technical Information Program
Washington, DC 1993

This publication was prepared by the NASA Center for AeroSpace Information,
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INTRODUCTION

This issue of *Aerospace Medicine and Biology* (NASA SP-7011) lists 305 reports, articles, and other documents recently announced in the NASA STI Database. The first issue of *Aerospace Medicine and Biology* was published in July 1964.

Accession numbers cited in this issue include:

Scientific and Technical Aerospace Reports (STAR) (N-10000 Series)	N93-27098 — N93-29391
International Aerospace Abstracts (IAA) (A-10000 Series)	A93-37501 — A93-41655

In its subject coverage, *Aerospace Medicine and Biology* concentrates on the biological, physiological, psychological, and environmental effects to which humans are 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. Applied research receives the most emphasis, but references to fundamental studies and theoretical principles related to experimental development also qualify for inclusion.

Each entry in the publication consists of a standard 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 include the original accession numbers from the respective announcement journals.

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

A cumulative index for 1993 will be published in early 1994.

Information on availability of documents listed, addresses of organizations, and CASI price schedules are located at the back of this issue.

TABLE OF CONTENTS

TYPICAL REPORT CITATION AND ABSTRACT

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ACCESSION NUMBER → **N93-12195 * #** Lockheed Engineering and Sciences, Co., Houston, TX. ← **CORPORATE SOURCE**

TITLE → **ASTRONAUT CANDIDATE STRENGTH MEASUREMENT USING THE CYBEX 2 AND THE LIDO MULTI-JOINT 2 DYNAMOMETERS Final Report**

AUTHORS → AMY E. CARROLL and ROBERT P. WILMINGTON May 1992 ← **PUBLICATION DATE**

CONTRACT NUMBER → (Contract NAS9-17900)

REPORT NUMBERS → (NASA-CR-185679; NAS 1.26:185679; LESC-30277) Avail: CASI HC ← **AVAILABILITY**

PRICE CODE → A03/MF A01

The Anthropometry and Biomechanics Laboratory in the man-Systems division at NASA's Johnson Space Center has as one of its responsibilities the anthropometry and strength measurement data collection of astronaut candidates. The anthropometry data is used to ensure that the astronaut candidates are within the height restrictions for space vehicle and space suit design requirments, for example. The strength data is used to help detect abnormalities or isolate injuries to muscle groups that could jeopardize the astronauts' safety. The Cybex II Dynamometer has been used for strength measurements from 1985 through 1991. The Cybex II was one of the first instruments of its kind to measure strength and similarity of muscle groups by isolating the specific joint of interest. In November 1991, a LIDO Multi-Joint II Dynamometer was purchased to upgrade the strength measurement data collection capability of the Anthropometry and Biomechanics Laboratory. The LIDO Multi-Joint II Dynamometer design offers several advantages over the Cybex II Dynamometer including a more sophisticated method of joint isolation and a more accurate and efficient computer based data collection system. Author

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

ACCESSION NUMBER → **A93-11150**

TITLE → **STUDIES TOWARDS THE CRYSTALLIZATION OF THE ROD VISUAL PIGMENT RHODOPSIN**

AUTHORS → W. J. DE GRIP, J. VAN OOSTRUM, and G. L. J. DE CALUWE

AUTHORS' AFFILIATION → (Nigmegen Catholic Univ., Netherlands) Journal of Crystal Growth (ISSN 0022-0248) vol. 122, no. 1-4 Aug. 1992 ← **JOURNAL TITLE** ← **PUBLICATION DATE**
p. 375-384. Research supported by SRON refs

CONTRACT NUMBER → (Contract NWO-SON-328-050)

Copyright

Results are presented of crystallization experiments on bovine rhodopsin, which established a restricted range of conditions which reproducibly yield rhodopsin crystals. Several parameters were optimized, including the detergent, the precipitant, additives, and pH. The crystals obtained so far are too small (less than 50 microns in any direction) or of insufficient order to allow high-resolution diffraction analysis. Several approaches are proposed for improving the average size, stability, and order of the rhodopsin crystals. I. S.

AEROSPACE MEDICINE AND BIOLOGY

A Continuing Bibliography (Suppl. 379)

September 1993

51

LIFE SCIENCES (GENERAL)

A93-38451* National Aeronautics and Space Administration. *Ames Research Center, Moffett Field, CA.*
8-OH-DPAT DOES NOT INTERFERE WITH HABITUATION TO MOTION-INDUCED EMESIS IN CATS
JAMES B. LUCOT and GEORGE H. CRAMPTON (Wright State Univ., Dayton, OH) Brain Research Bulletin (ISSN 0361-9320) vol. 26 1991 p. 919-921. refs
(Contract NCC2-229)
Copyright

Experiments were performed to determine if suppression of motion-induced emesis (motion sickness) by 8-OH-DPAT altered the development or retention of habituation to the motion stimulus. Cats received 8-OH-DPAT followed by provocative motion on three consecutive treatment days. A drug-free test on the fourth day resulted in an incidence of emesis that was not different from that obtained on the fourth consecutive day of drug-free motion testing. Three consecutive days of treatment with 8-OH-DPAT without motion had no effect on the incidence of motion sickness on the fourth day. It was concluded that suppression of motion sickness by 8-OH-DPAT does not alter the acquisition or retention of habituation. Author (revised)

A93-39280
FERROUS IRON OXIDATION BY ANOXYGENIC PHOTOTROPHIC BACTERIA
FRIEDRICH WIDDEL (Max-Planck-Inst. fuer Marine Mikrobiologie, Bremen, Germany), SYLVIA SCHNELL, SILKE HEISING (Konstanz Univ., Germany), ARMIN EHRENREICH, BERNHARD ASSMUS (Max-Planck-Inst. fuer Marine Mikrobiologie, Bremen, Germany), and BERNHARD SCHINK (Konstanz Univ., Germany) Nature (ISSN 0028-0836) vol. 362, no. 6423 April 29, 1993 p. 834-836. refs
Copyright

The reducing power of ferrous Fe is dramatically increased at pH values above 2-3, due to the formation of ferric hydroxy and oxyhydroxy compounds. It is presently noted that it may be possible for Fe (II) at around pH 7.0 to function as an electron donor for anoxygenic photosynthesis, and attention is given to purple, nonsulfur bacteria which can oxidize colorless Fe (II) to brown Fe (III), and reduce CO2 to cell material. It is thereby shown that oxygen-independent biological Fe oxidation was possible prior to the evolution of oxygenic photosynthesis. AIAA

A93-39703
AMINOHYDROXYBUTANE BISPHOSPHONATE AND CLENBUTEROL PREVENT BONE CHANGES AND RETARD MUSCLE ATROPHY RESPECTIVELY IN TAIL-SUSPENDED RATS
G. APSELOFF, B. GIRTEN, M. WALKER, D. R. SHEPARD, M. E. KRECIC, L. S. STERN, and N. GERBER (Ohio State Univ., Columbus) Journal of Pharmacology and Experimental *Therapeutics* (ISSN 0022-3565) vol. 264, no. 3 March 1993 p. 1071-1078.
Copyright

Hind-limb unloading by tail suspension of rats was used to examine the effectiveness of aminohydroxybutane bisphosphonate (AHBuBP) and clenbuterol in preventing bone loss and muscle atrophy, respectively. Rats were randomized into six groups of six: (1) unsuspended, saline; (2) unsuspended, saline, pair fed with group 3; (3) suspended, saline; (4) suspended, 0.03 mg/kg/day x 2 of AHBuBP; (5) suspended, 0.3 mg/kg/day x 2 of AHBuBP; and (6) suspended, 0.3 mg/kg/day x 2 of AHBuBP + clenbuterol (0.5 mg/kg/day i.p. x 6, then 1 mg/kg/day i.p. x 6). Animals in groups 3 to 6 were tail suspended for 14 days and allowed free mobility with their hind limbs unloaded. On days -2 and -1, before suspension on day 0, all rats received a single s.c. injection of either 2 ml/kg of normal saline (vehicle) or AHBuBP. On day 14, the rats were euthanized. It was found that pair feeding had no effect other than on food consumption and body weight. AHBuBP caused a dose-dependent increase in bone density in humeri, tibias and femurs, even in tail-suspended rats, relative to control unsuspended animals, with no significant difference in bone strength or stiffness between AHBuBP groups and unsuspended animals. Author (revised)

A93-39707
MATHEMATICAL MODEL FOR THE EXCHANGE OF GASES IN THE LUNGS WITH SPECIAL REFERENCE TO CARBON MONOXIDE
S. SELVAKUMAR, M. SHARAN, and M. P. SINGH (Indian Inst. of Technology, New Delhi, India) Medical & Biological Engineering & Computing (ISSN 0140-0118) vol. 30, no. 5 Sept. 1992 p. 525-532.
Copyright

A mathematical model has been formulated for the simultaneous exchange of gases O2, CO2, CO and N2 in the lungs. The model takes into account the physiological parameters, such as ventilation rate, diffusing capacity of the lungs, cardiac output, total volume of blood in the body and the interaction of gases in the blood. The nonlinear functions for representing O2, CO2 and CO dissociation curves have been used. The results predicted from the model are in good agreement with those based on the ventilation/perfusion relationships. The COHb build-up in the blood, computed from the model as a function of exposure time, is in good agreement with the experimental values. The consideration of capillary blood pO2 as a constant value, instead of an independent variable, is shown to introduce a maximum error of 0.25 per cent in the blood COHb. The model is applied to analyze the COHb levels at high altitude. Author

A93-39711
NEUROPHARMACOLOGY OF MOTION SICKNESS AND EMESIS - A REVIEW
N. TAKEDA, M. MORITA, S. HASEGAWA, A. HORII, T. KUBO, and T. MATSUNAGA (Osaka Univ., Japan) Acta Oto-Laryngologica, Supplement (ISSN 0365-5237) vol. 501 1993 p. 10-15.
Copyright

Histamine H1-receptors are involved in the development of the symptoms and signs of motion sickness, including emesis. On provocative motion stimulus, a signal for sensory conflict activates

the histaminergic neuron system, and the histaminergic descending impulse stimulates H1-receptors in the emetic center of the brain stem. The histaminergic input to the emetic center through H1-receptors is independent of dopamine D2-receptors in the chemoreceptor trigger zone and serotonin 5HT3-receptors in the visceral afferent, which are also involved in the emetic reflex. Antihistamines block emetic H1-receptors to prevent motion sickness. Acetylcholine muscarinic receptors are involved in the generation of signals for sensory conflict. Anti-cholinergic drugs prevent motion sickness by modifying the neural store to facilitate the acquisition of habituation to provocative motion. Author

A93-39712
MOTION SICKNESS INDUCED BY SINUSOIDAL LINEAR ACCELERATION IN RATS
A. HORII, N. TAKEDA, M. MORITA, T. KUBO, and T. MATSUNAGA (Osaka Univ., Japan) Acta Oto-Laryngologica, Supplement (ISSN 0365-5237) vol. 501 1993 p. 31-33.
Copyright

The characteristics of linear acceleration to cause motion sickness of rats were examined using pica as a behavioral index of motion sickness. A vestibular sled was used to generate sinusoidal linear acceleration. At 0.4 Hz and with a peak acceleration of 0.15 G, the effectiveness of linear acceleration in inducing motion sickness was X-axis greater than Y-axis greater than Z-axis. At 0.4 Hz and along the X-axis, rats suffered from more severe motion sickness with a high peak G load (0.15 G) than with a low one (0.08 G). Along the X-axis and with a peak acceleration of 0.15 G, the severity of motion sickness was not related to frequency (0.4, 0.6 Hz). Author (revised)

A93-39715
INHIBITION OF EGF-INDUCED SIGNAL TRANSDUCTION BY MICROGRAVITY IS INDEPENDENT OF EGF RECEPTOR REDISTRIBUTION IN THE PLASMA MEMBRANE OF HUMAN A431 CELLS
P. J. RIJKEN, R. P. DE GROOT, N. VAN BELZEN, S. W. DE LAAT, J. BOONSTRA, and A. J. VERKLEIJ (Utrecht, Rijksuniversiteit, Netherlands) Experimental Cell Research (ISSN 0014-4827) vol. 204, no. 2 Feb. 1993 p. 373-377.
Copyright

Epidermal growth factor (EGF)-induced c-fos and c-jun expression is strongly suppressed in microgravity. We investigate here whether this is due to inhibition of processes occurring during the initiation of EGF-induced signal transduction. For this purpose, EGF-induced receptor clustering is used as a marker. The lateral distribution of EGF receptors is directly visualized at an ultrastructural level by the label-fracture method. Quantification of the receptor distributions shows that EGF-induced receptor redistribution is similar under normal and microgravity conditions. This suggests that microgravity influences EGF-induced signal transduction downstream of EGF binding and EGF receptor redistribution, but upstream of early gene expression in human A431 cells. Author

A93-39717
ALTERING THE POSITION OF THE FIRST HORIZONTAL CLEAVAGE FURROW OF THE AMPHIBIAN (XENOPUS) EGG REDUCES EMBRYONIC SURVIVAL
H. YOKOTA, A. W. NEFF, and G. M. MALACINSKI (Indiana Univ., Bloomington) International Journal of Developmental Biology (ISSN 0214-6282) vol. 36, no. 4 Dec. 1992 p. 527-535.
Copyright

The animal/vegetal cleavage ratio (AVCR), defined as the ratio of the height of the animal blastomere to the height of the Xenopus embryo at the 8 cell stage, can be shifted by placing embryos in novel gravitational fields: clinostating (microgravity simulation) increases AVCR, and centrifugation (hypergravity simulation) reduces AVCR. This report contributes to an understanding of the subcellular mechanism responsible for the furrow relocation and assesses its significance. Embryo inversion and D2O immersion were found to increase AVCR, and cold shock was found to reduce AVCR. Based on the additive or antagonistic effects of combined treatments, it is postulated that the primary cause of AVCR changes is an alteration in the distribution of yolk platelets and the rearrangement of microtubule arrays. Embryos with a decreased AVCR exhibited reduced survival in early developmental stages, indicating serious difficulties in cleavage, blastulation and/or gastrulation. Cold-shocked embryos with a reduced AVCR could be rescued by D2O pretreatment or clinostating, an observation which supports the notion that changes accompanying AVCR modifications represent the primary cause of the reduction in percent survival. Author

A93-40308* National Aeronautics and Space Administration, Washington, DC.
MICROFOSSILS OF THE EARLY ARCHEAN APEX CHERT - NEW EVIDENCE OF THE ANTIQUITY OF LIFE
J. W. SCHOPF (California Univ., Los Angeles) Science (ISSN 0036-8075) vol. 260, no. 5108 April 30, 1993 p. 640-646. refs
(Contract NAGW-825; NGR-05-007-407; NSF BSR-86-13583; NAGW-2147)
Copyright

Eleven taxa (including eight heretofore undescribed species) of cellularly preserved filamentous microbes, among the oldest fossils known, have been discovered in a bedded chert unit of the Early Archean Apex Basalt of northwestern Western Australia. This prokaryotic assemblage establishes that trichomic cyanobacterium-like microorganisms were extant and morphologically diverse at least as early as about 3465 million years ago and suggests that oxygen-producing photoautotrophy may have already evolved by this early stage in biotic history. Author (revised)

A93-40548* National Aeronautics and Space Administration, Washington, DC.
ABSENCE OF A GROWTH HORMONE EFFECT ON RAT SOLEUS ATROPHY DURING A 4-DAY SPACEFLIGHT
BIAN JIANG, ROLAND R. ROY, CHRISTINE NAVARRO, and V. R. EDGERTON (California Univ., Los Angeles) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 2 Feb. 1993 p. 527-531. Research supported by NASA, Pennsylvania State Univ., and Genentech refs
Copyright

The effect of a 4-day-long spaceflight on the size and the enzyme properties of soleus fibers of rats and the effects of exogenous growth hormone (GH) on the atrophic response of the soleus muscle were investigated in four groups of rats: (1) control, (2) control plus GH treatment, (3) flight, and (4) flight plus GH treatment. Results showed that the fiber size and the type of myosin heavy chain expressed fibers (but not the metabolic properties) of the soleus were affected by four days of weightlessness and that the effects were not ameliorated by the administration of growth hormone. AIAA

A93-40773
OXYGEN REGIME IN THE FRONTAL CEREBRAL CORTEX OF MONKEYS DURING A TWO-WEEK SPACE FLIGHT [KISLORODNYJ REZHIM LOBNOJ KORY GOLOVNOGO MOZGA OBEZ'YANY V PROTSESSE 2-NEDEL'NOGO KOSMICHESKOGO POLETA]
V. P. KROTOV, V. A. YUSHIN, A. VATSEK, V. I. KOROL'KOV, A. SHEBELA, A. N. TRUZHENNIKOV, and V. YU. KUNYAEV Aviakosmicheskaya i Ekologicheskaya Meditsina (ISSN 0233-528X) vol. 26, no. 2 Mar.-Apr. 1992 p. 42-46. In RUSSIAN refs
Copyright

Changes in the oxygen partial pressure (pO2) in the frontal cerebral cortex of Macaca mulata monkeys fitted with platinum electrodes were measured during a two-week space flight. It was found that, in monkeys undergoing the space flight, there was an initial increase of pO2, which reached a maxium of 203 percent on days 5-8, followed by normalization by day 11, whereas the pO2 values in the cortical zone of on-ground control monkeys remained at the base level. Results of an analysis of the pO2-curve

oscillations in the frequency range 0.2-0.01 Hz for the in-flight monkeys revealed a shift of the oscillation power spectrum in the long-wave direction, suggesting a decrease in the rate of tissue metabolism. AIAA

A93-41075* National Aeronautics and Space Administration, Washington, DC.
GEOGRAPHY OF END-CRETACEOUS MARINE BIVALVE EXTINCTIONS
DAVID M. RAUP and DAVID JABLONSKI (Chicago Univ., IL) Science (ISSN 0036-8075) vol. 260, no. 5110 May 14, 1993 p. 971-973. refs
(Contract NAGW-1508; NAGW-1527; NSF EAR-90-05744; NSF INT-86-2045)
Copyright

Analysis of the end-Cretaceous mass extinction, based on 3514 occurrences of 340 genera of marine bivalves (Mollusca), suggests that extinction intensities were uniformly global; no latitudinal gradients or other geographic patterns are detected. Elevated extinction intensities in some tropical areas are entirely a result of the distribution of one extinct group of highly specialized bivalves, the rudists. When rudists are omitted, intensities at those localities are statistically indistinguishable from those of both the rudist-free tropics and extratropical localities. Author

A93-41124
MYOSIN AND TROPONIN CHANGES IN RAT SOLEUS MUSCLE AFTER HINDLIMB SUSPENSION
MARINA CAMPIONE, SIMONETTA AUSONI, CHARLES Y. GUEZENNEC, and STEFANO SCHIAFFINO (Padova, Univ.; CNR, Padua, Italy; Centre d'Etudes et des Recherches de Medecine Aerospatiale, Bretigny-sur-Orge, France) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 3 March 1993 p. 1156-1160. Research supported by ASI refs
Copyright

We examined the myosin heavy-chain (MHC), troponin T (TnT), and troponin I (TnI) isoform composition in the rat soleus muscle after 21 days of hindlimb suspension using electrophoretic and immunoblotting analysis with specific monoclonal antibodies. The suspended soleus showed a shift in the MHC isoform distribution with a marked increase (from 1.0 to 33 percent) in the relative amount of type IIa and IIx MHC and a corresponding decrease in type I MHC. However, type IIb MHC, which represents a major component in fast-twitch muscles, was not detected in suspended soleus muscles. TnT and TnI isoform composition was also changed with the appearance of fast-type TnI and TnT bands. However, a high-mobility TnT band, which represents a major component in fast-twitch muscles, was not expressed in the suspended soleus. These isoform transitions may be related to the increased maximal velocity of shortening and higher calcium sensitivity previously reported in the rat soleus after hindlimb suspension. Author (revised)

A93-41167* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NOREPINEPHRINE CONTENT IN DISCRETE BRAIN AREAS AND NEUROHYPOPHYSIAL VASOPRESSIN IN RATS AFTER A 9-D SPACEFLIGHT (SLS-1)
JEANNETTE FAREH, JEAN-MARIE COTTET-EMARD, JEAN-MARC PEQUIGNOT (Lyon I, Univ., France), GARY JAHNS (NASA, Ames Research Center, Moffett Field, CA), JOHN MEYLOR (Lockheed Engineering & Sciences Co.; NASA, Ames Research Center, Moffett Field, CA), MICHEL VISO, DIDIER VASSAUX (CNES, Paris, France), GUILLEMETTE GAUQUELIN, and CLAUDE GHARIB (Lyon I, Univ., France) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 6 June 1993 p. 507-511. Research supported by DRET and CNES refs
Copyright

The norepinephrine (NE) content in discrete brain areas and the vasopressin content in the neurohypophysial system were assessed in rats after a 9-d spaceflight and after a recovery period. The NE content in the locus coeruleus decreased significantly in spaceflight rats, but showed no difference between control and flight animals after a 9-d recovery. These findings were probably due to an acute stress undergone during landing. The NE content was unchanged in the A2 and A5 cell groups. In rats flown aboard SLS-1, the vasopressin content was increased in the posterior pituitary, and was significantly decreased in the hypothalamus. We conclude that the NE depletion in the locus coeruleus and the alteration in vasopressin release were consistent with an acute stress, likely occurring during and/or after landing. These changes tend to mask the actual neuroendocrine modifications caused by microgravity. Author (revised)

A93-41388
RELATIVE RESISTANCE OF BIOFILMS AND PLANKTONIC CELLS OF COMMON MOLDS AND YEASTS TO ANTIMICROBIALS
D. G. AHEARN, P. A. GANDHI, L. L. MAY (Georgia State Univ., Atlanta), D. L. PRICE (Interface Research Corp., Scottsdale, AZ), and S. A. CROW (Georgia State Univ., Atlanta) Jul. 1992 7 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by Krug Life Sciences, Inc. refs
(Contract EPA-CR-818696-01-0)
(SAE PAPER 921212) Copyright

Various antimicrobials, including benzalkonium chloride, dimethyl benzyl ammonium chloride, chlorhexidine, pofyhexamethylene biguanide and hydrogen peroxide, were screened for their inhibitory effects against planktonic and adhered cells of selected yeasts and molds. A resistant strain of Serratia marcescens was employed as a control. Quaternary compounds often merely damaged cells; recoveries varied with the neutralizing medium and whether agar or broths were used. In general, quaternary compounds and biguanides at concentrations of less than 1.0 percent gave static inhibition, but with borate ions present biocidal activity was observed for certain compounds. Cells dried to polyethylene surfaces were usually more resistant to disinfectant concentrations than planktonic cells, but in a few instances dried biofilms showed increased susceptibility. Molds such as Aspergillus flavus and A. furmigatus were more resistant to certain biguanides than the yeasts Candida albicans and C. parapsilosis. Hydrogen peroxide tested at a maximum concentration of 3.0 percent, in general, was one of the most effective disinfectants for adhered and planktonic cells. Author

A93-41390* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
EFFECTS OF REFRIGERATING PREINOCULATED VITEK CARDS ON MICROBIAL PHYSIOLOGY AND ANTIBIOTIC SUSCEPTIBILITY
JOYCE A. SKWERES, VIRGINIA J. BASSINGER, S. K. MISHRA (Krug Life Sciences, Inc., Houston, TX), and DUANE L. PIERSON (NASA, Johnson Space Center, Houston, TX) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921214) Copyright

Reference cultures of 16 microorganisms obtained from the American Type Culture Collection and four clinical isolates were used in standardized solutions to inoculate 60 cards for each test strain. A set of three ID and three susceptibility cards was processed in the Vitek AutoMicrobic System (AMS) immediately after inoculation. The remaining cards were refrigerated at 4 C, and sets of six cards were removed and processed periodically for up to 17 days. The preinoculated AMS cards were evaluated for microorganism identification, percent probability of correct identification, length of time required for final result, individual substrate reactions, and antibiotic minimal inhibitory/concentration (MIC) values. Results indicate that 11 of the 20 microbes tested withstood refrigerated storage up to 17 days without detectable changes in delineating characteristics. MIC results appear variable, but certain antibiotics proved to be more stable than others. The results of these exploratory studies will be used to plan a microgravity experiment designed to study the effect of microgravity on microbial physiology and antibiotic sensitivity. Author

A93-41391 National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
ALTERED IMMUNOLOGICAL RESPONSE IN MICE SUBJECTED TO STRESS AND EXPOSED TO FUNGAL SPORES
VISWANATH P. KURUP, HONGYUNG CHOI, ANOOPA KUMAR, PAZHAYANNUR S. MURALI (Wisconsin Medical College, Milwaukee), S. K. MISHRA (Krug Life Sciences, Inc., Houston, TX), and DUANE L. PIERSON (NASA, Johnson Space Center, Houston, TX) Jul. 1992 9 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by NASA, Krug Life Sciences, Inc., and USVA refs
(SAE PAPER 921215) Copyright

Space flight and related factors such as stress appear to have an adverse effect on astronauts' immune systems. The presence of potentially pathogenic microbes including several genera of fungi reported from spacecraft environment may be a cause of concern in such situations. In order to study the role of such organisms in causing opportunistic or allergic diseases in crewmembers, we have tried to develop an animal model. BALB/c mice were suspended upside down for varying periods of time to induce stress, and their lymphocyte functions were evaluated. These studies indicate that the stress resulted in lowered mitogen induced lymphocyte stimulation as represented by 3H-thymidine uptake. We have also studied the ability of these animals to respond to Aspergillus fumigatus spores. The results of the study clearly demonstrate a definite down-regulation in T-cell proliferation and a higher incidence of infection with A. fumigatus.
Author (revised)

A93-41520* National Aeronautics and Space Administration, Washington, DC.
INACTIVATION OF A MODEL COLIPHAGE VIRUS IN WATER BY IODINE
GAIL M. BRION and JOANN SILVERSTEIN (Colorado Univ., Boulder) Jul. 1992 9 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by NASA refs
(SAE PAPER 921361) Copyright

Until now, NASA's space water reuse research program has not considered the transport of water-borne infectious enteric viruses; however, viral diseases probably are a signifficant concern in long-duration space missions. To simplify monitoring and prediction of pathogen distribution, model indicator strains historically have been used. In this research, the male specific RNA coliphage MS-2 is used as a model of enteric viruses due to their similar size and biochemical composition. Inactivation of some water-borne enteric viruses by iodine has previously been characterized. In this paper, iodine inactivation of the model coliphage MS-2 in buffered water is compared with earlier bench-scale disinfection survival data and with survival in iodinated simulated shower water used in a test water recycling system.
Author (revised)

A93-41551 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
DARK CYCLE MONITORING OF BIOLOGICAL SPECIMENS ON SPACE STATION FREEDOM
ARSHAD MIAN and SHERRY CHUANG (NASA, Ames Research Center, Moffett Field, CA) Jul. 1992 9 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Previously announced in STAR as N93-19103 refs
(Contract RTOP 476-14-03)
(SAE PAPER 921393) Copyright

The operational environment for biological research on Space Station Freedom will incorporate video technology for monitoring plant and animal subjects. The video coverage must include dark-cycle monitoring because early experiments will use rodents that are nocturnal and therefore most active during the dark part of the daily cycle. Scientific requirements for monitoring during the dark cycle are exacting. Infrared (IR) or near-IR sensors are required. The trade-offs between these two types of sensors are based on engineering constraints, sensitivity spectra, and the quality of imagery possible from each type. This paper presents results of a study conducted by the Biological Flight Research Projects Office in conjunction with the Spacecraft Data Systems Branch at ARC to investigate the use of charged-coupled-device and IR cameras to meet the scientific requirements. Also examined is the effect of low levels of near-IR illumination on the circadian rhythm in rats.
Author

N93-27122*# Umpqua Research Co., Myrtle Creek, OR. Aerospace Div.
REGENERABLE BIOCIDE DELIVERY UNIT, VOLUME 1 Final Report
JAMES E. ATWATER and RICHARD R. WHEELER, JR. Sep. 1992 310 p
(Contract NAS9-18361)
(NASA-CR-185701; NAS 1.26:185701; URC-80356) Avail: CASI HC A14/MF A03

The Microbial Check Valve (MCV), which is currently used aboard the Shuttle Orbiter for disinfection of the potable water supply, is an expendable flow-through canister containing iodinated ion exchange resin. Means for extension of MCV life are desirable to avoid resupply penalties. The Phase 1 Regenerable Biocide Delivery Unit program demonstrated the feasibility of regenerating an MCV in situ, using a strong aqueous elemental iodine solution resulting from diversion of the MCV influent to a packed bed containing iodine crystals. In small column tests, eight manual regenerations of an MCV resin were accomplished. The term Regenerative Microbial Check Valve (RMCV) was adopted describing this new technology. The Phase 2 program resulted in the development of a full scale and fully autonomous prototype RMCV, capable of maintaining residual I(sub 2) levels between 2.0 - 4.0 mg/L for prolonged periods. During six months of testing at the Space Station baseline flow rate of 120 cm(sup 3)/min, the prototype RMCV underwent nine regenerations. RMCV life cycle tests, using a variety of influent streams, were conducted over an eighteen month period to determine the useful lives of MCV's incorporating this new technology and to determine ultimate failure mechanisms. MCV life extensions of 130 fold were demonstrated, limited only by the Phase 2 performance period. Based upon this work, it is certain that RMCV units can be developed to provide unattended biocide addition for the thirty year life of Space Station Freedom, or for other longer duration applications such as a Lunar Base or Mars mission. RMCV technology was also demonstrated capable of delivering, on demand, a concentrated aqueous I(sub 2) solution for potential use as a disinfectant during transient episodes of microbial surface contamination, for the control of biofilm formation, or as a preventative measure in systems which are particularly susceptible to the growth of microorganisms.
Author (revised)

N93-27152# Civil Aeromedical Inst., Oklahoma City, OK.
VARIATIONS OF TIME-TO-INCAPACITATION AND CARBOXYHEMOGLOBIN VALUES IN RATS EXPOSED TO TWO CARBON MONOXIDE CONCENTRATIONS Final Report
DONALD C. SANDERS, BOYD R. ENDECOTT, ROXANE M. RITTER, and ARVIND K. CHATURVEDI May 1993 18 p
(DOT/FAA/AM-93/7) Avail: CASI HC A03/MF A01

It has been suggested that passenger protective breathing equipment protect aircraft passengers from smoke for 5 min during an evacuation phase and for 35 min during an in-flight-plus-evacuation phase. Carbon monoxide (CO) is one of the most abundant smoke components and is the major threat in most fire atmospheres. Time-to-incapacitation (t(sub i)) is an end-point related to escape from a fire, and variations in t(sub i) measurements at specific CO concentrations have not been statistically documented. Therefore, variance in t(sub i) at two CO concentrations that produce 5- and 35-min t(sub i) in rats were determined; blood carboxyhemoglobin (COHb) saturation at t(sub i) was measured. Fifty male Sprague-Dawley rats were individually exposed to each CO concentration in a chamber equipped with a rotating cage, and t(sub i) was recorded as the time from insertion

of the animal into the cage until it could no longer walk. In another set of experiments, blood COHb saturation was determined in rats exposed to these CO concentrations at stepwise intervals less than t(sub i). At incapacitation and at the end of each exposure interval, rats were quickly removed from the cage and killed for blood collection and COHb quantization. Values (mean +/- SD) for measured parameters were: for the 5-min t(sub i) study, CO = 5706 +/- 178 ppm, t(sub i) = 5.0 +/- 0.36 min, and COHb = 80.8 +/- 1.3%; for the 35-min t(sub i) study, CO = 1902 +/- 33 ppm, t(sub i) = 34.8 +/- 6.8 min, and COHb = 71.2 +/- 1.0%. COHb levels tended to plateau prior to incapacitation. Coefficients of variation for t(sub i) were 7.2% and 19.5% for the 5- and 35-min study, respectively. The significant difference in the two COHb levels and the approach of COHb to a maximal level before incapacitation suggest that blood COHb saturation levels may not necessarily be indicative of the onset of incapacitation. Author (revised)

N93-27360*# Umpqua Research Co., Myrtle Creek, OR. Aerospace Div.

REGENERABLE BIOCIDE DELIVERY UNIT, VOLUME 2 Final Report

JAMES E. ATWATER and RICHARD R. WHEELER, JR. Sep. 1992 98 p

(Contract NAS9-18361)

(NASA-CR-185701-VOL-2; NAS 1.26:185701-VOL-2; URC-80356) Avail: CASI HC A05/MF A02

Source code for programs dealing with the following topics are presented: (1) life cycle test stand-parametric test stand control (in BASIC); (2) simultaneous aqueous iodine equilibria-true equilibrium (in C); (3) simultaneous aqueous iodine equilibria-pseudo-equilibrium (in C); (4) pseudo-(fast)-equilibrium with iodide initially present (in C); (5) solution of simultaneous iodine rate expressions (Mathematica); (6) 2nd order kinetics of I2-formic acid in humidity condensate (Mathematica); (7) prototype RMCV onboard microcontroller (CAMBASIC); (8) prototype RAM data dump to PC (in BASIC); and (9) prototype real time data transfer to PC (in BASIC). CASI

N93-27989# National Defence Research Establishment, Umea (Sweden). Microbiology Div.

INTRACELLULAR TARGETING OF THE YERSINIA YOPE CYTOTOXIN IN MAMMALIAN CELLS INDUCES ACTIN MICROFILAMENT DISRUPTION

ROLAND ROSQVIST, AAKE FORSBERG, and HANS WOLF-WATZ (Umea Univ., Sweden.) Dec. 1991 8 p Sponsored in part by Swedish Board of Technical Development Repr. from Infection and Immunity, v. 59, no. 12, Dec. 1991 p 4562-4569

(Contract SMRC-07490-5A; SNSRC-4426-3011) (ISSN 0281-0263)

(FOA-B-40420-4.4; ETN-93-93765) Copyright Avail: CASI HC A02/MF A01

An experiment which showed that isolated Yop (Yersinia outer membrane proteins) present in Pathogenic Yersinia spp. that encode a number of essential virulence determinants, cause cytoxic effects in vitro if the proteins are introduced intracellulary into the eukaryotic cell, is described. Isolated Yop proteins of Yersinia pseudotuberculosis were found to disrupt the microfilament structure only when microinjected intracellulary into the host cell. In particular, YopE was demonstrated to be directly involved in the cytotoxication, whereas YopD seems to have a critical role in translocating the YopE protein through the host cell membrane. These results elucidate the requirement for at least some of the Yop proteins to leave the pathogen during infection. ESA

N93-28199# National Defence Research Establishment, Umea (Sweden). Cell and Microbiology Dept.

PLASMID ENCODED VIRULENCE OF YERSINIA

H. WOLF-WATZ, A. FORSBERG, R. ROSQVIST, I. BOELIN, K. ERICKSON, L. NORLANDER, M. RIMPILAEINEN, T. BERGMAN, and S. HAAKANSSON 1991 5 p Prepared in cooperation with Umea Univ., Sweden

(FOA-B-40419-4.4; ETN-93-93764) Avail: CASI HC A01/MF A01

The expression of virulence plasmid encoded virulence determinants is discussed and it is concluded that the three virulent species of Yersinia contain homologous virulence plasmids that encode a number of temperature inducible Ca(2+) regulated proteins (Yops (Yersinia outer membrane proteins)). Mapping and regulation of Yop genes is discussed and it is concluded that the expression of the Yops is regulated at the level of transcription involving negative as well as positive control elements encoded by the Ca(2+) region. Work which resulted in the conclusion that YopH and YopE are essential virulence determinants which obstruct the primary host defense by preventing phagocytosis is discussed. ESA

N93-28200# National Defence Research Establishment, Umea (Sweden). Microbiology Div.

CHARACTERIZATION AND CLASSIFICATION OF STRAINS OF FRANCISELLA TULARENSIS ISOLATED IN THE CENTRAL ASIAN FOCUS OF THE SOVIET UNION AND IN JAPAN

G. SANDSTROEM, A. SJOESTEDT, M. FORSMAN, N. V. PAVLOVICH (Rostov State Univ., Rostov-on-Don, USSR.), and B. N. MISHANKIN (Rostov State Univ., Rostov-on-Don, USSR.) Jan. 1992 4 p Repr. from Journal of Clinical Microbiology, v. 30, no. 1, Jan. 1992 p 172-175

(FOA-B-40421-4.4; ETN-93-93766) Copyright Avail: CASI HC A01/MF A01

An experiment which suggests that classification of strains of Francisella on the basis of 16S rRNA analysis may be preferable to classification on the basis of biochemical analysis is described and results and conclusions given. The two subspecies of Francisella tularensis, F. tularensis subsp. tularensis (type A) and F. tularensis subsp. palaearctica (type B), differ from each other in biochemistry and virulence. Strains of type A are believed to be confined to North America, whereas strains of type B occur in Europe, in Asia, and in North America. Moreover, the existence of two other subspecies, designated F. tularensis subsp. mediaasiatica and F. tularensis subsp. palaearctica japonica, has been suggested for strains of F. tularensis isolated in the central Asian focus of the Soviet Union and in Japan, respectively. Strains biochemically classified as F. tularensis subsp. mediaasiatica or F. tularensis subsp. palaeartica japonica were investigated by hybridization with probes specific to 16S rRNAs of the two main species. Furthermore, the virulence and biochemical characteristics of the strains were compared with those of strains belonging to type A and type B. It was found that 16S rRNAs of F. tularensis subsp. mediaasiatica and F. tularensis subsp. palaeartica japonica hybridize with the probe specifc to a geniotype proposed, genotype A (type A), which shows that strains genetically related to this subspecies are found outside North America. However, the central Asian strains differed from type A and type B strains when investigated by fermentation of glucose. It was concluded that the results of the biochemical tests could not be unambiguously used for differentiation of strains into F. tularensis subsp. palaearctica or F. tularensis subsp. tularensis. ESA

N93-28212# National Defence Research Establishment, Umea (Sweden). Cell Biology and Microbiology Dept.

USE OF RNA HYBRIDIZATION IN THE DIAGNOSIS OF A CASE OF ULCEROGLANDULAR TULAREMIA

M. FORSMAN, K. KUOPPA, A. SJOESTEDT, and A. TAERNVIK (Umea Univ., Sweden.) 1990 2 p Repr. from Eur. J. Clin. Microbiol. Infect Dis., v. 9, 1990 p 784-785

(FOA-B-40422-4.4; ETN-93-93767) Avail: CASI HC A01/MF A01

A case study in which 16S ribosomal RNA of Francisella tularensis were successfully used in the diagnosis of a wound specimen from a patient with ulceroglandular tularemia is presented. A genus specific probe was constructed from the 16S ribosomal RNA which was used in the diagnosis. It was shown that the hybridization technique is much more rapid than culture procedures and carries a lower risk of laboratory infection. As illustrated, the

hybridization procedure is also useful for determination of the Francisella tularensis biovar. ESA

N93-28415*# Pennsylvania State Univ., University Park.
ELECTROPHORETIC SEPARATION OF CELLS AND PARTICLES FROM RAT PITUITARY AND RAT SPLEEN Final Report, period ending 31 Mar. 1993
WESLEY C. HYMER 31 Mar. 1993 81 p
(Contract NAG8-807)
(NASA-CR-193073; NAS 1.26:193073) Avail: CASI HC A05/MF A01

There are 3 parts to the IML-2 TX-101 experiment. Part 1 is a pituitary cell culture experiment. Part 2 is a pituitary cell separation experiment using the Japanese free flow electrophoresis unit (FFEU). Part 3 is a pituitary secretory granule separation experiment using the FFEU. The objectives of this three part experiment are: (1) to determine the kinetics of production of biologically active growth hormone (GH) and prolactin (PRL) in rat pituitary GH and PRL cells in microgravity (micro-g); (2) to investigate three mechanisms by which a micro-g-induced lesion in hormone production may occur; and (3) to determine the quality of separations of pituitary cells and organelles by continuous flow electrophoresis (CFE) in micro-g under conditions where buoyancy-induced convection is eliminated. Author (revised)

N93-28651# Massachusetts Inst. of Tech., Cambridge. Center for Environmental Health Sciences.
COMPARATIVE MUTAGENESIS OF HUMAN CELLS IN VIVO AND IN VITRO
W. G. THILLY May 1993 23 p
(Contract DE-FG02-86ER-60448)
(DE93-012269; DOE/ER-60448/T6) Avail: CASI HC A03/MF A01

This annual progress report describes advances made in combining denaturing gradient gel electrophoresis with high fidelity DNA amplification and with mismatch amplification (MAMA) along with advances in high efficiency restriction enzyme digestion of wild type sequences. Also, theoretical studies on gene mutations in oncogenesis are described. DOE

N93-28683# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. CENTRAL EURASIA: LIFE SCIENCES
30 Mar. 1993 32 p Transl. into ENGLISH from various Russian articles
(JPRS-ULS-93-005) Avail: CASI HC A03/MF A01

Translated articles cover the following topics: aerospace medicine; agricultural science; biotechnology; environment; immunology; laser bioeffects; medicine; microbiology; physiology; public health; psychology; and radiation biology. CASI

N93-28684# Joint Publications Research Service, Arlington, VA.
JPRS REPORT: SCIENCE AND TECHNOLOGY. CENTRAL EURASIA: LIFE SCIENCES
30 Dec. 1992 65 p Transl. into ENGLISH from various Russian articles
(JPRS-ULS-92-027) Avail: CASI HC A04/MF A01

Translated articles cover the following topic: aerospace medicine; biochemistry; biotechnology; environment; epidemiology; genetics; medicine; pharmacology and toxicology; physiology; psychology; and radiation biology. CASI

N93-28848# Hunter Coll., New York, NY.
GENE TRANSCRIPTION AND ELECTROMAGNETIC FIELDS
A. S. HENDERSON 1992 7 p
(Contract DE-FG01-89CE-34023)
(DE93-010854; DOE/CE-34023/T1) Avail: CASI HC A02/MF A01

Our overall aim is to obtain sufficient information to allow us to ultimately determine whether ELF EM field exposure is an initiating factor in neoplastic transformation and/or if exposure can mimic characteristics of the second-step counterpart in neoplastic disease. This aim is based on our previous findings that levels of some transcripts are increased in cells exposed to EM fields. While the research is basic in nature, the ramifications have bearing on the general safety of exposure to EM fields in industrial and everyday life. A large array of diverse biological effects are reported to occur as the result of exposure to elf EM fields, suggesting that the cell response to EM fields is at a basic level, presumably initiated by molecular and/or biophysical events at the cell membrane. The hypothesized route is a signal transduction pathway involving membrane calcium fluxes. Information flow resulting from signal transduction can mediate the induction of regulatory factors in the cell, and directly affect how transcription is regulated. DOE

N93-28890# Oak Ridge National Lab., TN.
INTRODUCTIONS TO THE PROCEEDINGS OF THE FOURTEENTH SYMPOSIUM ON BIOTECHNOLOGY FOR FUELS AND CHEMICALS
J. WOODWARD, C. E. WYMAN (Midwest Research Inst., Golden, CO.), and B. J. GOODMAN (Midwest Research Inst., Golden, CO.) 1992 9 p Symposium held in Gatlinburg, TN, 11-15 May 1992
(Contract DE-AC05-84OR-21400; DE-AC02-83CH-10093)
(DE93-006235; CONF-920508-6) Avail: CASI HC A02/MF A01

This report is a collection of introductions to sessions made at the Fourteenth Symposium on Biotechnology for Fuels and Chemicals. DOE

N93-28952*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
AMINO ACID SEQUENCES FOR THE BINDING REGIONS IN SERUM ALBUMIN PROTEINS Patent Application
DANIEL C. CARTER, inventor (to NASA) 1 Mar. 1993 17 p
(NASA-CASE-MFS-28402-1; NAS 1.71:MFS-28402-1; US-PATENT-APPL-SN-024547) Avail: CASI HC A03/MF A01

In accordance with the present invention, biologically active protein fragments can be constructed which contain only those specific portions of the serum albumin family of proteins such as regions known as subdomains IIA and IIIA which are primarily responsible for the binding properties of the serum albumins. The artificial serums that can be prepared from these biologically active protein fragments are advantageous in that they can be produced much more easily than serums containing the whole albumin, yet still retain all or most of the original binding potential of the full albumin proteins. In addition, since the protein fragment serums of the present invention can be made from non-natural sources using conventional recombinant DNA techniques, they are far safer than serums containing natural albumin because they do not carry the potentially harmful viruses and other contaminants that will be found in the natural substances. NASA

N93-29174*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
PROCESS FOR SELECTIVELY RECOVERING ALGAE AND PROTOZOA Patent Application
DAVID A. NOEVER, inventor (to NASA) (Universities Space Research Association, Huntsville, AL.) 12 Apr. 1993 8 p
(NASA-CASE-MFS-26124-1-NPO; NAS 1.71:MFS-26124-1-NPO; US-PATENT-APPL-SN-045142) Avail: CASI HC A02/MF A01

A process is presented for selectively recovering swimming microorganisms from a liquid wherein the liquid is placed in a container and the container is rotated such that the coriolis force and the swimming activity of the microorganisms cause the microorganisms to concentrate in rings at different radii from the axis of rotation of the liquid. Liquid is withdrawn from the container at different distances from the axis of rotation of the container to selectively recover the microorganisms. NASA

N93-29181# Ohio State Univ., Columbus. Research Foundation.
REGULATION OF ALTERNATIVE CO2 FIXATION PATHWAYS IN PROCARYOTIC AND EUCARYOTIC PHOTOSYNTHETIC ORGANISMS

1992 3 p
(Contract DE-FG02-91ER-20033)
(DE93-012109; DOE/ER-20033/1) Avail: CASI HC A01/MF A01

The major goal of this project is to determine how microorganisms regulate the assimilation of CO2 via pathways alternative to the usual Calvin reductive pentose phosphate scheme. In particular, we are interested in the molecular basis for switches in CO2 metabolic paths. Several earlier studies had indicated that purple nonsulfur photosynthetic bacteria assimilate significant amounts of CO2 via alternative non-Calvin routes. We have deleted the gene that encodes. RubisCo (ribulose bisphosphate carboxylase/oxygenase) in both the Rhodobacter sphaeroids and Rhodospirillum rubrum. The R. sphaeroides RubisCO deletion strain (strain 16) could not grow under photoheterotrophic conditions with malate as electron donor and CO2 as the electron acceptor; however the R. rub RubisCO deletion strain (strain I-19) could. Over the past year we have sought to physiologically characterize strain 16PHC. We found that, 16PHC exhibited rates of whole-cell CO2 fixation which were significantly higher than strain 16. Strain 16PHC could not grow photolithoautotrophically in a CO2 atmosphere; however, CO2 fixation catalyzed by photoheterotrophically grown 16PHC was repressed by the addition of DMSO. Likewise, we found that cells initially grown in the presence of DMSO could induce the CO2 fixation system when DMSO was removed. Thus, these results suggested that both PHC and I-19 could be used to study alternative CO2 fixation reactions and their significance in R. sphaexoides and R. rubrum. DOE

N93-29216*# Texas A&M Univ., College Station. Research Foundation.
GROWING WHEAT TO MATURITY IN REDUCED GAS PRESSURES Final Report, 1 Apr. 1992 - 30 Jun. 1993
EDWARD J. RYKIEL, JR., MALCOLM C. DREW, and BRAD D. ETTER 30 Jun. 1993 70 p
(Contract NAG9-582)
(NASA-CR-193245; NAS 1.26:193245) Avail: CASI HC A04/MF A01

The main objective of this project was to determine assimilation of CO2 and efficiency of water use in wheat grown to maturity in a low pressure total gas pressure environment. A functional test of the low pressure plant growth chamber system was accomplished in February and March of 1993 wherein this objective was partially achieved. Plants were grown to maturity in the chambers. Data were actively collected during the first 29 days. The plants were allowed to maintain themselves at the CO2 compensation point until day 45 of the study at which point active atmospheric regulation was resumed. This provided data at the vegetative and reproductive stages of the life cycle of the plants. However, this information may not be representative of the performance of the plants due to the loss of low pressure on a number of days during the study, which affected the plants by changing the pressure potential of the tissues. The performance of the system will be discussed on a component by component basis. The maintenance of the plants at the CO2 compensation point was driven by the failure of the computer program operating the system. The software problems that arose during the functional test have since been corrected. Results from the functional test also indicated that the plants were not receiving adequate light and nutrients. The growth chambers have been relocated and the growth room modified to compensate for these deficiencies.
Derived from text

N93-29274# European Space Agency, Paris (France).
PHOTOBIOLOGICAL INVESTIGATIONS ON SPORES OF STREPTOMYCES GRISEUS
BIRGIT KELLER (Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Cologne, Germany.) Nov. 1992 118 p Transl. into ENGLISH of Photobiologische Untersuchungen an Sporen von Streptomyces griseus (Cologne, Germany, DLR) Mar. 1991 p 1-111 Original language document was announced as N91-32748
(ESA-TT-1269; DLR-FB-91-14; ETN-93-93715) Avail: CASI HC A06/MF A02; Original German version available from DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Germany, HC

Ultraviolet action spectra of inactivation were compared between wet and dry state spores of the Streptomyces griseus. In vacuum, the spores are more resistant to UV by a factor of 2 than under wet conditions. Their photoreactivability is reduced. The cross sections for induction of DNA (Deoxyribonucleic Acid) double strand breaks and for inactivation show similar dependence on wavelengths. ESA

52

AEROSPACE MEDICINE

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

A93-39261* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RADIATION EXPOSURE PREDICTIONS FOR SHORT-DURATION STAY MARS MISSIONS
SCOTT A. STRIEPE, JOHN E. NEALY, and LISA C. SIMONSEN (NASA, Langley Research Center, Hampton, VA) Journal of Spacecraft and Rockets (ISSN 0022-4650) vol. 29, no. 6 Nov.-Dec. 1992 p. 801-807. AAS and AIAA, Spaceflight Mechanics Meeting, Colorado Springs, CO, Feb. 24-26, 1992 refs
(AAS PAPER 92-107) Copyright

The human radiation environment for several short-duration stay manned Mars missions is predicted using the Mission Radiation Calculation program, which was developed at NASA Langley Research Center. This program provides dose estimates for Galactic cosmic rays (GCR) and large and ordinary solar proton flare events for various amounts of effective spacecraft shielding and a given time history of the spacecraft's heliocentric position. The results of this study show that most of the missions can survive the most recent large flares if a 25 g/sq cm storm shelter is assumed. The dose predictions show that missions during solar minima are not necessarily the minimum dose cases, due to increased GCR contribution during this time period. The direct transfer mission studied has slightly lower doses than the outbound Venus swingby mission, with the greatest dose differences for the assumed worst case scenario. The GCR dose for a mission can be reduced by having the crew spend some fraction of its day nominally in the storm shelter. Author (revised)

A93-39704* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
HUMAN PERFORMANCE AND PHYSIOLOGICAL FUNCTION DURING A 24-HR EXPOSURE TO 1 PERCENT BROMOTRIFLUOROMETHANE (HALON 1301)
D. S. CALKINS, J. J. DEGIOANNI, M. N. TAN, J. R. DAVIS, and D. L. PIERSON (Krug Life Sciences; NASA, Johnson Space Center, Houston, TX) Fundamental and Applied Toxicology (ISSN 0272-0590) vol. 20, no. 2 Feb. 1993 p. 240-247.
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Performance and physiological measurements were obtained from four pairs of men exposed for 24 hr to 1 percent (10,000 ppm) Halon 1301 (CBrF3) and to air with order counterbalanced using a double-blind protocol. Cognitive and motor performance was assessed before, during, and after the exposures, using seven scales of the Automated Portable Testing System, which produced 13 measures of performance. Halon inhalation induced decrements in 2 of the 13 measures, but actual and estimated magnitudes of the decrements were no greater than 5 percent of baseline values. Physiological data obtained before, during, and after the exposures revealed significant changes during Halon inhalation for 6 of the 52 variables assessed; however, all physiological values remained within clinically acceptable limits. No cardiovascular effects were

noted. This study demonstrated that exposure to 1 percent Halon 1301 for 24 hr can produce minor disturbance of central nervous system function as assessed by cognitive tasks. Author (revised)

A93-39705* *National Aeronautics and Space Administration.* Lyndon B. Johnson Space Center, Houston, TX.
TOXICOKINETICS OF INHALED BROMOTRIFLUOROMETHANE (HALON 1301) IN HUMAN SUBJECTS
C. W. LAM, F. W. WEIR, K. WILLIAMS-CAVENDER, M. N. TAN, T. J. GALEN, and D. L. PIERSON (NASA, Johnson Space Center, Houston, TX) Fundamental and Applied Toxicology (ISSN 0272-0590) vol. 20, no. 2 Feb. 1993 p. 231-239.
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Bromotrifluoromethane (Halon 1301, CBrF3), is used as a fire extinguishant in the Space Shuttle, where several scenarios, such as a fire or a faulty alarm, could lead to its discharge resulting in a Halon 1301 concentration of up to 1 percent in the cabin atmosphere. The effect of Halon 1301 on mental performance and physiologic function was investigated in a NASA-sponsored human inhalation study in which four pairs of male subjects were each exposed in a double-blind fashion for 24 hr to 1 percent Halon 1301 and to air in two exposures about 1 week apart. Blood and breath samples from the exposed subjects were collected to provide dosimetric and toxicokinetic information. Halon 1301 blood levels increased rapidly and approached a steady state within 2 hr of the beginning the exposure; the steady-state concentration was approximately 3-4.5 microg/ml. Breath samples collected during exposures closely reflected chamber concentrations. Analysis of postexposure blood samples revealed that Halon 1301 was eliminated biphasically with an average t(1/2) alpha and t(1/2) beta of 4.5 min and 200 min, respectively.
Author (revised)

A93-39706
BAROTRAUMA IN BOEING 737 CABIN CREW
H. W. KORTSCHOT and W. J. OOSTERVELD (Academical Medical Centre, Amsterdam, Netherlands) ORL: Journal for Oto-rhino-laryngology and Its Related Specialties (ISSN 0301-1569) vol. 55, no. 2 Mar.-Apr. 1993 p. 114-116.
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Several aircrew members of a Boeing 737 aircraft were referred to our department because they suffered from a barotrauma. The fast rate of pressure change during the descent of a Boeing 737 aircraft, as compared to the Boeing 747, DC-10 and Airbus 310 aircrafts, is most likely the cause of the development of the barotraumata. Author

A93-39709
HIGH-ALTITUDE PULMONARY EDEMA WITH PULMONARY THROMBOEMBOLISM
S. NAKAGAWA, K. KUBO, T. KOIZUMI, T. KOBAYASHI, and M. SEKIGUCHI (Shinshu Univ., Matsumoto, Japan) Chest (ISSN 0012-3692) vol. 103, no. 3 March 1993 p. 948-950.
Copyright

High-altitude pulmonary edema (HAPE) is a form of noncardiogenic pulmonary edema. The pathophysiology of HAPE remains unclear. A case of HAPE was associated with pulmonary thromboembolism of a left upper pulmonary artery. Pulmonary thromboembolism was an important factor in development of HAPE in this case. Author

A93-39710
INTRAOCULAR PRESSURE AND RETINAL VASCULAR CHANGES DURING TRANSIENT EXPOSURE TO MICROGRAVITY
T. H. MADER, C. R. GIBSON, M. CAPUTO, N. HUNTER, G. TAYLOR, J. CHARLES, and R. T. MEEHAN (U.S. Army, Madigan Army Medical Center, Tacoma, WA) American Journal of Ophthalmology (ISSN 0002-9394) vol. 115, no. 3 March 15, 1993 p. 347-350.
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We measured intraocular pressures and retinal vascular diameters from 11 subjects during 20 seconds of microgravity produced by parabolic flight on board a KC-135 aircraft. Intraocular pressures increased 58 percent during parabolic flight compared to baseline values (19 +/- 1 mm Hg vs 12 +/- 1 mm Hg, respectively; P less than 0.001). A 4 percent reduction in the caliber of retinal arteries was also noted during microgravity, but this change did not achieve statistical significance. The increase in the intraocular pressure and the trend of arteries to constrict are thought to result from cephalad shifts in intravascular and extravascular body fluids as a result of the absence of the 1g hydrostatic gradient. The results of our study confirm that this fluid shift and its effects on the eye occur rapidly, within 20 seconds of exposure to microgravity. Author (revised)

A93-39713
LONG-LASTING NEUROPSYCHOLOGICAL CHANGES AFTER A SINGLE HIGH ALTITUDE CLIMB
G. CAVALETTI and G. TREDICI (Inst. for Biomedical Sciences, Monza, Italy) Acta Neurologica Scandinavica (ISSN 0001-6314) vol. 87, no. 2 Feb. 1993 p. 103-105.
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Acute neuropsychological changes due to high altitude climbing without supplementary oxygen are well known. However, many climbers report vague symptoms of brain dysfunction after return to sea level, suggesting that long-lasting neuropsychological impairment may ensue even after a single ascent. In this study, we evaluated a series of neuropsychological functions in a group of 11 climbers who ascended over 5000 m. Besides memory impairment, reaction time and concentration were also less efficient when the climbers were evaluated 75 days after their return to sea level, confirming that even a single high altitude climb may be harmful for central nervous system functions.
Author (revised)

A93-39714
THE PREDICTION OF THE ADAPTATION OF CIRCADIAN RHYTHMS TO RAPID TIME ZONE CHANGES
S. SUVANTO, M. HARMA, and J. T. LAITINEN (Inst. of Occupational Health, Vantaa, Finland) Ergonomics (ISSN 0014-0139) vol. 36, no. 1-3 Jan.-Mar. 1993 p. 111-116.
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Factors which could explain individual differences in the resynchronization speed of circadian rhythms of salivary melatonin and subjective alertness after transmeridian flights over 10 time zones were investigated. The data were gathered in female subjects aged 33.0 +/- 6.9 years by measurements of the circadian rhythms of melatonin excretion and altertness at 2 h intervals in Helsinki (Finland) two days before westward flight to Los Angeles (USA), where the measurements were repeated on the 2nd day after the flights and on the 2nd day in Finland after return flight. The age, day length, marital status, and physical exercise explained the acrophase adaptation of the melatonin rhythm after the westward flight, while the day length, neuroticism, and extroversion were the relevant factors after eastward flight. The marital status, neuroticism, and physical exercise explained the variation of the acrophase adjustment of the alertness rhythm after westward flight, and the age and eveningness after eastward flight. It is concluded that the amount of daylight and personality are the best predictors of the circadian rhythm adaptation after transmeridian flights.
Author (revised)

A93-39716
MICROGRAVITY AND ORTHOSTATIC INTOLERANCE - CAROTID HEMODYNAMICS AND PERIPHERAL RESPONSES
P. J. LACOLLEY, B. M. PANNIER, J. L. CUCHE, J. S. HERMIDA, S. LAURENT, P. MAISONBLANCHE, J. L. DUCHIER, B. I. LEVY, and M. E. SAFAR (Hopital Broussais, Paris, France) American Journal of Physiology (ISSN 0002-9513) vol. 264, pt. 2 Feb. 1993 p. H588-H594.
Copyright

A ground-based model (24 h of bed rest (BR) with head-down tilt (HDT)) was used to investigate the cardiovascular deconditioning responsible for orthostatic intolerance, frequently observed after weightlessness flights. This experimental deconditioning is shown

to be distinguished by an increase of mean blood pressure, with increased total peripheral resistances (TPRs). Systolic tangential tension of the carotid arterial wall, cardiac output and frequency, and plasma norepinephrine and epinephrine were not significantly altered, while plasma dopamine was increased. Cardiovascular homeostasis was challenged before and after 24 h of BR with HDT, through -40 mmHg lower body negative pressure (LBNP). Systolic tangential tension of the carotid wall was decreased, with a decrease of systolic pressure and cardiac output; increased heart rate was likely due to an increase of sympathetic drive with a decrease of vagal braking. The overall picture was not changed after 24 h of BR with HDT, except for a lack of increase of TPRs. Author (revised)

A93-39725
EFFECTS OF LONG-TERM WEIGHTLESSNESS ON ROLL CIRCULARVECTION
D. G. D. WATT (McGill Univ., Montreal, Canada), J. P. LANDOLT (Defence and Civil Inst. of Environmental Medicine, Toronto, Canada), and L. R. YOUNG (MIT, Cambridge, MA) Canadian Aeronautics and Space Journal (ISSN 0008-2821) vol. 39, no. 1 March 1993 p. 52-55. CASI, Astronautics Conference, 7th, Ottawa, Canada, Nov. 4-6, 1992 Research supported by Canadian Space Agency, DND, and Medical Research Council of Canada refs

The 8-day Spacelab IML-1 mission employed simulations, measurements and their results' analysis to investigate the effects of continuous roll circularvection. The results obtained suggest that roll circularvection temporarily increases during weightlessness, reflecting a process of compensation for the need to solve problems in spatial orientation, rather than constituting the result of such a compensating process. AIAA

A93-40549* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
MAPPING OF ELECTRICAL MUSCLE STIMULATION USING MRI
GREGORY R. ADAMS, ROBERT T. HARRIS, DANIEL WOODARD, and GARY A. DUDLEY (Bionetics Corp., Biomedical and Environmental Labs.; NASA, Kennedy Space Center, Cocoa Beach, FL; Ohio Univ., Athens) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 2 Feb. 1993 p. 532-537. refs
(Contract NAS10-11624)
Copyright

The pattern of muscle contractile activity elicited by electromyostimulation (EMS) was mapped and compared to the contractile-activity pattern produced by voluntary effort. This was done by examining the patterns and the extent of contrast shift, as indicated by T2 values, im magnetic resonance (MR) images after isometric activity of the left m. quadriceps of human subjects was elicited by EMS (1-sec train of 500-microsec sine wave pulses at 50 Hz) or voluntary effort. The results suggest that, whereas EMS stimulates the same fibers repeatedly, thereby increasing the metabolic demand and T2 values, the voluntary efforts are performed by more diffuse asynchronous activation of skeletal muscle even at forces up to 75 percent of maximal to maintain performance. AIAA

A93-40550 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
DIRECT MEASUREMENT OF CAPILLARY BLOOD PRESSURE IN THE HUMAN LIP
S. E. PARAZYNSKI, B. J. TUCKER, M. ARATOW, A. CRENSHAW, and A. R. HARGENS (NASA, Ames Research Center, Moffett Field, CA) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 2 Feb. 1993 p. 946-950. Research supported by NASA and Stanford Medical Scholars Program refs
Copyright

In this study, we developed and tested a new procedure for measuring microcirculatory blood pressures above heart level in humans. Capillary and postcapillary venule blood pressures were measured directly in 13 human subjects by use of the servonulling micropressure technique adapted for micropuncture of lip capillaries. Pressure waveforms were recorded in 40 separate capillary vessels and 14 separate postcapillary venules over periods ranging from 5 to 64 s. Localization and determination of capillary and postcapillary vessels were ascertained anatomically before pressure measurements. Capillary pressure was 33.2 +/- 1.5 (SE) mm Hg in lips of subjects seated upright. Repeated micropunctures of the same vessel gave an average coefficient of variation of 0.072. Postcapillary venule pressure was 18.9 +/- 1.6 mm Hg. This procedure produces a direct and reproducible means of measuring microvascular blood pressures in a vascular bed above heart level in humans. Author (revised)

A93-40774
NEW TECHNOLOGY FOR THE ANALYSIS OF THE RESULTS OF AN ULTRASOUND EXPERIMENT PERFORMED IN AVIATION-MEDICINE MEDICAL EXAMINATION [NOVAYA TEKHNOLOGIYA ANALIZA REZUL'TATOV ULTRAZVUKOVOGO ISSLEDOVANIYA V TSELYAKH VRACHEBNO-LETNOJ EKSPERTIZY]
A. YU. VASIL'EV, A. P. IVANCHIKOV, and A. P. KOZLOVSKIJ Aviakosmicheskaya i Ekologicheskaya Meditsina (ISSN 0233-528X) vol. 26, no. 2 Mar.-Apr. 1992 p. 62-65. In RUSSIAN refs
Copyright

The paper describes an equipment complex developed for the digital processing of ultrasound images, developed for a military-aviation-research hospital. The system consists of a personal computer with peripheral equipment, specialized installations for the display and processing of video information, and a system for storing video data. The complex can be used with ultrasound scanners ETS-01-R, Aloka-260, Aloka-630, and Toshiba-77. Results of the processing ultrasound scans of 100 aviators, performed for diagnosing various health problems, are discussed. AIAA

A93-41117
INTERACTIONS BETWEEN HB, MG, DPG, ATP, AND CL DETERMINE THE CHANGE IN HB-O2 AFFINITY AT HIGH ALTITUDE
HEIMO MAIRBAEURL, OSWALD OELZ, and PETER BAERTSCH (Yale Univ., New Haven, CT; Zuerich, Universitaetsspital, Zurich; Eidgenoessische Sportschule, Magglingen, Switzerland) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 1 Jan. 1993 p. 40-48. Research supported by Eidgenoessische Sportschule Magglingen refs
(Contract SNSF-3,200,0092,85; FFWF PROJECT P-6221)
Copyright

The intracellular distribution of the various species of Hb, DPG, ATP, Cl, and Mg was determined to evaluate the role that various potential ligands of Hb play in altering standard P(O2) at 50 percent O2 saturation (P sub 50, st) and to clarify the mechanism of an 2,3 diphosphoglycerate (DPG) independent increase in P sub 50, st during early altitude acclimatization. Subjects were examined at low altitude and during the early phase of acclimatization to high altitude (3 days at 4,559 m) to determine ligand binding by Hb and Hb-O2 affinity. Results indicate that P sub 50, st increased at high altitude (HA) by about 4.5 Torr and the concentration of DPG increased by 28 percent. The sum of concentrations of all liganded Hb species increased, reaching 79 percent of its total change within 22 h after ascent, which is mainly attributed to the change in the concentration of Hb (DPG) (+77 percent of total increase). AIAA

A93-41118
RESPONSE OF GENIOGLOSSUS EMG ACTIVITY TO PASSIVE TILT IN MEN
MICHAEL J. WASICKO, SUSAN L. KNUTH, and JAMES C. LEITER (Dartmouth College, Lebanon, NH) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 1 Jan. 1993 p. 73-81. Research supported by Parker B. Francis Foundation refs
(Contract NIH-HL-07449; NIH-HL-01998)
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The effect of passive tilt on upper airway muscle activity in

men was analyzed under the assumption that changes in degree of tilt would change local pressure at the carotid baroreceptors. Data obtained revealed that the transient response of electromyogram (EMG) activity of the genioglossus to tilt was biphasic: when moving from upright to supine position, there was a rapid increase in activity during the tilt maneuver followed by a progressive decline. Thus passive tilt from upright to supine position results in inhibition of EMG independent of changes in level of arousal. AIAA

A93-41119 National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
ORTHOSTATIC INTOLERANCE DURING A 13-DAY BED REST DOES NOT RESULT FROM INCREASED LEG COMPLIANCE
FRANCOIS M. MELCHIOR and SUZANNE M. FORTNEY (NASA, Johnson Space Center, Houston, TX) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 1 Jan. 1993 p. 286-292. Research supported by DRET refs
(Contract RTOP 199-15-11-14; RTOP 199-14-11-13)
Copyright

Increased leg compliance (LC) has been proposed as a mechanism for orthostatic intolerance after spaceflight or bed rest. Using venous occlusion plethysmography with mercury-in-Silastic strain gauge, we evaluated LC before, during, and after a 13-day head-down bed rest in 10 men. LC was measured by the relationship between the increased calf areas at thigh cuff occlusions of 20, 30, 50, 70, and 80 mmHg. Orthostatic tolerance was evaluated by a presyncopal-limited lower body negative pressure test before and after bed rest. The 10 subjects were divided into TOL (n= 5) and INT (n=5) groups for which the orthostatic tolerance was similar and lower after bed rest, respectively. For TOL (INT) before bed rest, calf area increases were 2.2 +/- 0.5 (SE) (1.3 +/- 0.4), 3.5 +/- 0.7 (2.3 +/- 0.5), 5.0 +/- 0.9 (3.5 +/- 0.6), 5.6 +/- 0.9 (4.4 +/- 0.6), and 6.4 +/- 1.1 (4.7 +/- 0.6) sq cm for thigh occlusion pressures of 20, 30, 50, 70, and 80 mmHg, respectively. Neither for INT nor for TOL were these results significantly changed by bed rest. These results suggest that other mechanisms than increased LC have to be taken into account to explain the decreased orthostatic tolerance induced by this 13-day bed rest. Author (revised)

A93-41120
HYPOXIC VENTILATORY RESPONSIVENESS IN TIBETAN COMPARED WITH HAN RESIDENTS OF 3,658 M
JIANGUO ZHUANG, TARSHI DROMA, SHINFU SUN, CRAIG JANES, ROBERT E. MCCULLOUGH, ROSANN G. MCCULLOUGH, ALLEN CYMERMAN, SHAO YUNG HUANG, JOHN T. REEVES, and LORNA G. MOORE (Tibet Inst. of Medical Sciences, Lhasa; Shanghai Inst. of Physiology, China; Colorado Univ., Denver; U.S. Army, Research Inst. of Environmental Medicine, Natick, MA) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 1 Jan. 1993 p. 303-311. refs
(Contract DAMD17-87-C-7202; NIH-HD-00681; NIH-HL-14985; NSF BNS-89-19645)
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A study is conducted of the ventilatory characteristics of Himalayan high-altitude residents, in view of their reportedly lower hemoglobin levels; 27 lifelong Tibetan residents of Lhasa were compared with 30 acclimatized Chinese newcomers that were matched for physical characteristics and exercise training, in order to determine whether Tibetans exhibited levels of ventilation and hypoxic ventilatory drives as great as the acclimatized newcomers. The Tibetans had higher hypoxic ventilatory response shape parameter A values and hypercapnic ventilatory responsiveness than the Han subjects. AIAA

A93-41121
MINIMAL HYPOXIC PULMONARY HYPERTENSION IN NORMAL TIBETANS AT 3,658 M
BERTRON M. GROVES, TARSHI DROMA, JOHN R. SUTTON, ROSANN G. MCCULLOUGH, ROBERT E. MCCULLOUGH, JIANGUO ZHUANG, GARRISON RAPMUND, SHINFU SUN, CRAIG JANES, and LORNA G. MOORE (Colorado Univ., Denver; Tibet Inst. of Medical Sciences, Lhasa, China; Sydney Univ., Australia) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 1 Jan. 1993 p. 312-318. refs
(Contract DAMD17-87-C-7202; NIH-HL-14985; NIH-HD-00681; NSF BNS-89-19645)
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Elevated pulmonary arterial pressure in high-altitude residents may be a maladaptive response to chronic hypoxia. If so, well-adapted populations would be expected to have pulmonary arterial pressures that are similar to sea-level values. Five normal male 22-yr-old lifelong residents of 3,600 m or higher elevations who were of Tibetan descent were studied in Lhasa (3,658 m) at rest and during near-maximal upright ergometer exercise. We found that resting mean pulmonary arterial pressure and pulmonary vascular resistance were within sea-level norms and were little changed while subjects breathed a hypoxic gas mixture. Near-maximal exercise increased cardiac output more than threefold to values of 18.3 +/- 1.2 l/min but did not elevate pulmonary vascular resistance. Breathing 100 percent O2 during near-maximal exercise did not reduce pulmonary arterial pressure or vascular resistance. We concluded that this small sample of healthy Tibetans with lifelong residence above 3,658 m had resting pulmonary arterial pressures that were normal by sea-level standards and exhibited minimal hypoxic pulmonary vasoconstriction, both at rest and during exercise. These findings are consistent with remarkable cardiac performance and high-altitude adaptation. Author (revised)

A93-41122* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
CEREBRAL BLOOD VELOCITY AND OTHER CARDIOVASCULAR RESPONSES TO 2 DAYS OF HEAD-DOWN TILT
MARY A. B. FREY, THOMAS H. MADER, JAMES P. BAGIAN, JOHN B. CHARLES, and RICHARD T. MEEHAN (U.S. Army, Madigan Army Medical Center, Tacoma, WA; Universities Space Research Association; NASA, Johnson Space Center, Houston; Texas Univ., Galveston) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 1 Jan. 1993 p. 319-325. refs
(Contract NIH-MO1-RR-00073)
Copyright

Spaceflight induces a cephalad redistribution of fluid volume and blood flow within the human body, and space motion sickness, which is a problem during the first few days of space flight, could be related to these changes in fluid status and in blood flow of the cerebrum and vestibular system. To evaluate possible changes in cerebral blood flow during simulated weightlessness, we measured blood velocity in the middle cerebral artery (MCA) along with retinal vascular diameters, intraocular pressure, impedance cardiography, and sphygmomanometry on nine men (26.2 +/- 6.6 yr) morning and evening for 2 days during continuous 10 deg head-down tilt (HDT). When subjects went from seated to head-down bed rest, their heart rate and retinal diameters decreased, and intraocular pressures increased. After 48 h of HDT, blood flow velocity in the MCA was decreased and thoracic impedance was increased, indicating less fluid in the thorax. Percent changes in blood flow velocities in the MCA after 48 h of HDT were inversely correlated with percent changes in retinal vascular diameters. Blood flow velocities in the MCA were inversely correlated (intersubject) with arterial pressures and retinal vascular diameters. Heart rate, stroke volume, cardiac output, systolic arterial pressure, and at times pulse pressure and blood flow velocities in the MCA were greater in the evening. Total peripheral resistance was higher in the morning. Although cerebral blood velocity is reduced after subjects are head down for 2 days, the inverse relationship with retinal vessel diameters, which have control analogous to that of cerebral vessels, indicates cerebral blood flow is not reduced. Author (revised)

A93-41123
INFLUENCE OF IN VIVO HYPOBARIC HYPOXIA ON FUNCTION OF LYMPHOCYTES, NEUTROCYTES, NATURAL KILLER CELLS, AND CYTOKINES

M. KLOKKER, A. KHARAZMI, H. GALBO, I. BYGBJERG, and B. K. PEDERSEN (Danish Armed Forces Health Services, Panum Inst.; Rigshospitalet; Copenhagen Univ., Denmark) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 3 March 1993 p. 1100-1106. Research supported by Danish Armed Forces Health Services, Royal Danish Air Force, and Simon Spies Foundation refs
Copyright

The effects of short-term hypoxia in vivo on the human cellular immune system are investigated. The experiments were carried out in a decompression chamber simulating cabin pressure in nondecompressed flight at an altitude of 18,000 ft with and without supplemental O2. The leukocyte concentration increased during hypobaric conditions because of an increased concentration of lymphocytes. The absolute and relative concentration of CD16+ natural killer (NK) cells increased markedly during hypoxia and returned to pretest values after 2 h of recovery. The NK cell activity of blood mononuclear cells boosted with interferon-alpha, interleukin-2 (IL-2), and indomethacin rose in parallel with unboosted NK cell activity during hypoxia. It is concluded that acute hypoxia induced marked alterations in the immune system and that the NK cells are especially sensitive to the hypoxic stimulus. AIAA

A93-41125
BODY FLUID COMPARTMENTS, RENAL BLOOD FLOW, AND HORMONES AT 6,000 M IN NORMAL SUBJECTS
INDER S. ANAND, Y. CHANDRASHEKHAR, SUDHAKAR K. RAO, RAVI M. MALHOTRA, ROBERTO FERRARI, JAGDISH CHANDANA, B. RAMESH, K. J. SHETTY, and M. S. BOPARAI (Postgraduate Inst. of Medical Education and Research, Chandigarh; High Altitude Medical Research Centre, Leh, India; Brescia Univ., Italy) Journal of Applied Physiology (ISSN 8750-7587) vol. 74, no. 3 March 1993 p. 1234-1239. refs
Copyright

Results are presented of an experimental study of body fluid compartments, renal blood flow, and a variety of plasma hormones in normal subjects residing at an altitude of 6000 m for more than 10 wk. There was a marked expansion of all the fluid spaces: total body sodium was 14 percent above normal, total body water was 18 percent above normal, plasma volume was 33 percent above normal, and blood volume was 84.5 percent above normal. The effective renal plasma flow was 55 percent lower than normal, but the reduction in the effective renal blood flow was 37 percent below normal because the hematocrit was high. It is suggested that a prolonged stay at extreme altitude can cause salt and water retention to an extent approximately similar to that in untreated congestive heart failure. It is likely that the stress of hypobaric hypoxia, cold, and exertion at high altitude increases catecholamines, which reduce renal blood flow and lead to a congestive state in normal subjects at extreme altitude. AIAA

A93-41165
EFFECTS OF SLEEP DEPRIVATION AND EXERCISE ON GLUCOSE TOLERANCE
T. VANHELDER, J. D. SYMONS, and M. W. RADOMSKI (Defence and Civil Inst. of Environmental Medicine; Toronto Univ., Canada) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 6 June 1993 p. 487-492. Research supported by NSERC refs
Copyright

The impact of sleep deprivation (SD) on the capability of subjects to handle an oral glucose load was studied. The effects of daily prolonged physical activity during SD were examined to verify the concept that the physical activity modulates glucose uptake and insuline secretion. It is concluded that sleep loss of 60 h combined with physical inactivity increased the insulin response to a glucose challenge provided there were no changes in glucose uptake. Physical activity reversed partially some of these effects. AIAA

A93-41168
EFFECTS OF DYNAMIC EXERCISE ON CARDIOVASCULAR REGULATION DURING LOWER BODY NEGATIVE PRESSURE
TAKESHI NISHIYASU, XIANGRONG SHI, CHRISTOPHER M. GILLEN, GARY W. MACK, and ETHAN R. NADEL (Yale Univ., New Haven, CT) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 6 June 1993 p. 517-521. refs
(Contract NIH-HL-20634; NIH-HL-39818)
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The cardiovascular responses to blood pooling at rest with those during moderate dynamic exercise are compared to test the hypothesis that the defense of arterial blood pressure against a marked decrease in venous return would be preserved during moderate dynamic exercise. In ten physically active men, blood pooling was varied by applying different levels of lower body negative pressure at rest and during various intensities of supine dynamic exercise. Results show that the change in total peripheral resistance with respect to stroke volume was linear confirming that peripheral vascular adjustments were proportional to changes in the heart's preload. It is concluded that the control characteristics of arterial blood pressure regulation are similar during rest and moderate dynamic exercise. AIAA

A93-41169 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PERFORMANCE AND MOOD-STATE PARAMETERS DURING 30-DAY 6 DEG HEAD-DOWN BED REST WITH EXERCISE TRAINING
CHARLES W. DEROSHIA and J. E. GREENLEAF (NASA, Ames Research Center, Moffett Field, CA) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 6 June 1993 p. 522-527. Research supported by U.S. Army refs
(Contract RTOP 199-21-12; RTOP 199-22-12; RTOP 199-22-22; RTOP 199-22-32; RTOP 199-22-44; NAG2-410)
Copyright

A study aimed at determining if the performance and mood impairments occur in bed-rested subjects, and if different exercise-training regimens modify or prevent them is presented. Eighteen healthy men were divided into three groups performing no exercise, isotonic exercise, and isokinetic exercise. Few deleterious changes occurred in performance and mood of the three groups which did not exceed baseline ambulatory levels. It is concluded that mood and performance did not deteriorate in response to prolonged bedrest and were not altered by exercise training. AIAA

A93-41170
FLOW CYTOMETRIC ANALYSIS OF LYMPHOCYTE SURFACE MARKERS FOLLOWING A 1-GY DOSE OF GAMMA RADIATION
DENNIS A. ROWLEY, WILLIAM A. KELLEY, and JULIAN H. MANDERS (Naval Hospital, Portsmouth, VA) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 6 June 1993 p. 528-533. Research supported by U.S. Navy refs
Copyright

Lymphocytes labeled with monoclonal antibodies were analyzed using a flow cytometer to compare the mean fluorescent intensity of several surface membrane antigens (markers) from irradiated and nonirradiated blood samples. Whole blood subjected to a 1-Gy (100-rad) dose of 1.25 MeV gamma radiation from a Co-60 radioisotope source was compared with nonirradiated blood drawn simultaneously from the same healthy subject. Results show that the fluorescent intensity is proportional to the number of intact binding sites on the lymphosyte surface and the observed decrement directly infers that damage occurred to some sites. It is concluded that there is a measurable effect on the lymphocyte membrane at a radiation dose at which many of the lymphocytes will survive. AIAA

A93-41171
CASE REPORT - CHRONIC SUB-DURAL HEMATOMA FOLLOWING HIGH-SPEED EJECTION
RICHARD WARBURTON (Royal Saudi Air Force Aeromedical Centre, King Abdulaziz Air Base, Saudi Arabia) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 6 June 1993 p. 534-537.
Copyright

A case of chronic subdural hematoma occurring in a pilot after a high speed ejection based on the survival envelope of the Mark 10 Martin Baker ejection seat is reported. The surgical treatment, recovery, and final assessment are discussed along with the possible causes of the subdural hematoma. It is pointed out that flight surgeon should analyze carefully the events in the case. Subdural hematoma is considered to be difficult to diagnose but it can cause late complications from an ejection. AIAA

A93-41468* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
METABOLIC RESPONSES TO SIMULATED EXTRAVEHICULAR ACTIVITY
REBECCA C. WILLIAMSON, PETER J. SHARER (Sterling Federal Systems, Inc., Palo Alto, CA), BRUCE W. WEBBON (NASA, Ames Research Center, Moffett Field, CA), and LISA R. RENDON (Foothill College, Los Altos Hill, CA) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921303) Copyright

Automatic control of the liquid cooling garment (LCG) worn by astronauts during extravehicular activity (EVA) would more efficiently regulate astronaut thermal comfort and improve astronaut productivity. An experiment was conducted in which subjects performed exercise profiles on a unique, supine upper body ergometer to elicit physiological and thermal responses similar to those achieved during zero-g EVAs. Results were analyzed to quantify metabolic rate, various body temperatures, and other heat balance parameters. Such data may lead to development of a microprocessor-based system to automatically maintain astronaut heat balance during extended EVAs. Author

A93-41546* National Aeronautics and Space Administration, Washington, DC.
POTENTIAL HEALTH HAZARDS FROM THERMAL DEGRADATION EVENTS - PARTICULATE VS. GAS PHASE EFFECTS
GUNTER OBERDORSTER, JURAJ FERIN, JACOB FINKELSTEIN, RAYMOND BAGGS (Rochester Univ., NY), D. M. STAVERT, and BRUCE E. LEHNERT (Los Alamos National Lab., NM) Jul. 1992 17 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(Contract NAGW-2356)
(SAE PAPER 921388) Copyright

The effect of instillation of ultrafine TiO2 particles (10-nm anatase-TiO2 and 12-nm rutile-TiO2 (administered in doses from 60 to 1000 microg/rat and 500 microg/rat, respectively) on the respiratory tract of exposed rats was compared to the effects of larger (250 nm anatase-TiO2 and 220-nm rutile-TiO2 particles (given in doses 500 or 1000 microg/rat and 500 microg/rat, respectively). These effects were also compared to the effects of inhalation of 20-nm and 250-nm anatase-TiO2 particles and inhalation with surrogate gas phase components (HF and HCl). It was found that ultrafine TiO2 particles induced greater inflammatory reaction in the lung, had greater adverse effect on alveolar macrophage-mediated clearance function, and had a greater potential to induce mediators which can adversely affect other lung cells than did larger-sized particles. Inhalation of surrogate gas phase components caused injury only to the upper respiratory tract, in contrast to the ultrafine particles, which affected the deep lung. AIAA

N93-27102*# Brown Univ., Providence, RI. Dept. of Pathology and Lab. Medicine.
MECHANICAL STIMULATION OF SKELETAL MUSCLE INCREASES PROSTAGLANDIN F2(ALPHA) SYNTHESIS AND CYCLOOXYGENASE ACTIVITY BY A PERTUSSIS TOXIN SENSITIVE MECHANISM
HERMAN H. VANDENBURGH, JANET SHANSKY, ROSA SOLERSSI, and JOSEPH CHROMIAK 1992 48 p
(Contract NAG2-414)
(NASA-CR-193041; NAS 1.26:193041) Avail: CASI HC A03/MF A01

Repetitive mechanical stimulation of differentiated skeletal muscle in tissue culture increases the production of prostaglandin F(sub 2(alpha)), an anabolic stimulator of myofiber growth. Within 4 h of initiating mechanical activity, the activity of cyclooxygenase, a regulatory enzyme in prostaglandin synthesis, was increased 82% (P is less than .005), and this increase was maintained for at least 24 h. Kinetic analysis of the stretch-activated cyclooxygenase indicated a two to three-fold decrease in the enzyme's K(sub m) with no change in V(sub max). The stretch-induced increase in enzymatic activity was not inhibited by cycloheximide, was independent of cellular electrical activity (tetrodotoxin-insensitive), but was prevented by the G protein inhibitor pertussis toxin. Pertussis toxin also inhibited the stretch-induced increases in PGF(sub 2(alpha)) production, and cell growth. It is concluded that stretch of skeletal muscle increases the synthesis of the anabolic modulator PGF(sub 2(alpha)) by a G protein-dependent process which involves activation of cyclooxygenase by a posttranslational mechanism.
Author (revised)

N93-27113*# Brown Univ., Providence, RI. Dept. of Pathology.
GROWTH FACTOR INVOLVEMENT IN TENSION-INDUCED SKELETAL MUSCLE GROWTH Semiannual Report, 1 Nov. 1992 - 30 Apr. 1993
HERMAN H. VANDENBURGH 30 Apr. 1993 8 p
(Contract NAG2-414)
(NASA-CR-193023; NAS 1.26:193023) Avail: CASI HC A02/MF A01

Long-term manned space travel will require a better understanding of skeletal muscle atrophy which results from microgravity. Astronaut strength and dexterity must be maintained for normal mission operations and for emergency situations. Although exercise in space slows the rate of muscle loss, it does not prevent it. A biochemical understanding of how gravity/tension/exercise help to maintain muscle size by altering protein synthesis and/or degradation rate should ultimately allow pharmacological intervention to prevent muscle atrophy in microgravity. The overall objective is to examine some of the basic biochemical processes involved in tension-induced muscle growth. With an experimental in vitro system, the role of exogenous and endogenous muscle growth factors in mechanically stimulated muscle growth are examined. Differentiated avian skeletal myofibers can be 'exercised' in tissue culture using a newly developed dynamic mechanical cell stimulator device which simulates different muscle activity patterns. Patterns of mechanical activity which significantly affect muscle growth and metabolic characteristics were found. Both exogenous and endogenous growth factors are essential for tension-induced muscle growth. Exogenous growth factors found in serum, such as insulin, insulin-like growth factors, and steroids, are important regulators of muscle protein turnover rates and mechanically-induced muscle growth. Endogenous growth factors are synthesized and released into the culture medium when muscle cells are mechanically stimulated. At least one family of mechanically induced endogenous factors, the prostaglandins, help to regulate the rates of protein turnover in muscle cells. Endogenously synthesized IGF-1 is another. The interaction of muscle mechanical activity and these growth factors in the regulation of muscle protein turnover rates with our in vitro model system is studied. Author

N93-27158# Civil Aeromedical Inst., Oklahoma City, OK. Office of Aviation Medicine.

VARIATIONS IN TIME-TO-INCAPACITATION AND BLOOD CYNANIDE VALUES FOR RATS EXPOSED TO TWO HYDROGEN CYANIDE GAS CONCENTRATIONS Final Report

ARVIND K. CHATURVEDI, BOYD R. ENDECOTT, ROXANE M. RITTER, and DONALD C. SANDERS May 1993 20 p
(DOT/FAA/AM-93-8) Avail: CASI HC A03/MF A01

It has been suggested that protective breathing devices protect aircraft passengers from combustion products for 5 min during evacuation and for 35 min during in-flight-plus-evacuation. Hydrogen cyanide (HCN), a combustion gas, produces incapacitation at relatively low concentrations, and time-to-incapacitation (t(sub i) is an applicable index for predicting escape from a fire. Variations in t(sub i) and blood cyanide (CN-) at specific HCN gas exposure concentrations have not been evaluated. Therefore, t(sub i) and blood CN- at t(sub i) for two HCN concentrations that produce 5- and 35-min t(sub i) were determined in male Sprague-Dawley rats. Blood CN- levels as a function of HCN exposure time were measured. Animals were individually exposed to HCN gas in a chamber equipped with a rotating cage, and t(sub i) was recorded as the time from insertion of the animal into the cage until it could no longer walk. At incapacitation and at selected intervals prior to t(sub i), rats were quickly removed from the cage and killed for blood collection and CN- quantitation. Chamber HCN concentrations were monitored during the exposures. For the 5-min test (mean plus or minus SD; n = 50), HCN gas = 184 plus or minus 10.0 ppm, t(sub i) = 5.1 plus or minus 0.8 min, and blood CN- = 2.3 plus or minus 0.5 micro-g/mL; for the 35-min test, HCN gas = 64 plus or minus 6.1 ppm, t(sub i) = 31.1 plus or minus 11.2 min, and blood CN- = 4.2 plus or minus 1.3 micro-g/mL. Blood CN- levels increased as a function of HCN exposure time, but the blood CN- level at the 5-min t(sub i) was half of the 35-min blood CN- level; the HCN gas uptake rate at 184 ppm was about 3 times that at 64 ppm. These findings suggest that the blood CN- level at incapacitation may vary substantially, depending upon the HCN exposure concentration; an equation is proposed for predicting blood CN- levels in rats. Author (revised)

N93-27409# Veterans Administration Hospital, San Francisco, CA.

SECONDARY INJURY FACTORS AND PREVENTATIVE TREATMENT Final Report, 15 Jul. 1987 - 14 Jul. 1991

A. I. FADEN May 1992 170 p
(Contract DHHS-R59-CCR-902269)
(PB93-176014) Avail: CASI HC A08/MF A02

The project included three independent, parallel studies: two involving experimental animals (head injury, spinal cord injury) and one involving humans (head injury). The underlying hypotheses for this work were that: (1) secondary, delayed injury resulting from actions of endogenous, autodestructive factors represents a significant contributing factor to the neurological disability that follows brain or spinal cord trauma; (2) that endogenous opioids (particularly dynorphin) and excitatory amino acids represent major classes of autodestructive factors; (3) that opioid receptor antagonists, or N-methyl-D-aspartate (NMDA) receptor antagonists administered within the first hours of trauma, improve neurological outcome; (4) that kappa-selective opioid antagonists are more effective than non-selective antagonists in treating central nervous system trauma; and (5) that magnetic resonance spectroscopy (MRS) may enhance prognostic abilities in CNS trauma by monitoring metabolic changes and the response to treatment.
NTIS

N93-27654# California Univ., Irvine. Center for Neurobiology of Learning and Memory.

ANALYSIS OF NEURAL SYSTEMS INVOLVED IN MODULATION OF MEMORY STORAGE Final Report, 1 Jan. 1990 - 31 Dec. 1992

JAMES L. MCGAUGH 1 Feb. 1993 6 p
(Contract N00014-90-J-1626)
(AD-A262418) Avail: CASI HC A02/MF A01

The aims of this research project were to investigate the involvement of opiate and GABAergic systems, in different brain regions, in regulating the storage of memory for different types of tasks. The proposed experiments were based on previous findings providing extensive evidence that memory storage is influenced by treatments affecting neuromodulatory systems in the amygdala as well as preliminary evidence suggesting the possibility that such influences might be limited to restricted domains (or forms) of learning and memory. The view that GABAergic and opiate drugs act by influencing memory storage is supported by previous, as well as recent evidence that the drugs do not induce state-dependency. That is, the effects on retention performance do not depend upon a congruence between drug states at the time of training (or shortly after training) and retention testing. The research supported by this grant has provided additional evidence that memory storage is influenced by opiate and GABAergic influences. Within the range of tasks examined, the effects did not depend upon the forms of learning and memory examined. Both the amygdala and septum appear to be involved in regulating GABAergic influences on memory and the effects appear to be mediated through cholinergic influences. DTIC

N93-27923# Army Aeromedical Research Lab., Fort Rucker, AL.

THE USE OF ELECTROPHYSIOLOGICAL AND COGNITIVE VARIABLES IN THE ASSESSMENT OF DEGRADATION DURING PERIODS OF SUSTAINED WAKEFULNESS Final Report

CARLOS A. COMPERATORE, JOHN A. CALDWELL, JR., ROBERT L. STEPHENS, JIM A. CHIARAMONTE, and JACQUELYN Y. PEARSON Dec. 1992 64 p
(Contract DA PROJ. 3M1-62787-A-897)
(AD-A263033; USAARL-93-5) Avail: CASI HC A04/MF A01

Army aviation personnel often encounter work schedules which require the transition from daytime to nighttime duty hours without the benefit of an adaptation period. Rotations from daytime and nighttime duty hours, particularly those that occur within a 24-hour period, usually result in loss of sleep, fatigue, and cognitive degradation. Strategies in the scheduling of sleep, meals, work, and exercise are currently under study with the purpose of identifying patterns that assist in the physiological adaptation to nighttime duty hours. These coping strategies are composed of countermeasures designed to prevent the sleep loss and chronic fatigue usually associated with rapid transitions from daytime to nighttime duty hours. The study of shiftwork coping strategies requires the empirical characterization of effective countermeasures which prevent chronic fatigue and preserve normal cognitive function. In the laboratory, the study of variables such as alertness, sensory processing, reaction time, and cognitive processing assessment approach requires the use of multidisciplinary test batteries that not only challenge cognitive processes, but also document the functional status of brain regions associated with sensory processing and alertness. The aim of this study was to evaluate the usefulness of a test battery designed to characterize the state of alertness and cognitive ability of subjects involved in postponing sleep for approximately 60 consecutive hours. DTIC

N93-28122# Los Alamos National Lab., NM. Life Sciences Div.

EVALUATION OF NO(X)-INDUCED TOXICITY Final Report, 1 Jul. 1985 - 30 Sep. 1992

BRUCE E. LEHNERT 31 Dec. 1992 229 p
(Contract DA PROJ. 3M1-61102-BS-15)
(AD-A261034) Avail: CASI HC A11/MF A03

Investigations conducted from FY85-FY93 in the project entitled evaluation of NO(x)-induced toxicity are summarized. During the course of the studies, investigations were undertaken to address numerous objectives. Specific information provided is formatted in the context of the objective(s) it concerns, a brief summary of accomplishments and findings that are detailed in the section, and citations of reports and publications that have emanated in total or in part from research performed during the accomplishment objective(s). Each section begins with its own Introduction, which is then followed by a Materials and Methods section, a Results section and a Summary or Discussion. Author (revised)

N93-28293# Ohio State Univ., Columbus. Coll. of Pharmacy.
13 C NMR SPECTRA OF ALLOSTERIC EFFECTORS OF HEMOGLOBIN
STANISLAW OSTROWSKI, THOMAS G. BURKE, and WALDEMAR PRIEBE 1993 6 p Prepared in cooperation with Texas Univ., Houston
(Contract N00014-90-J-1648)
(AD-A262979) Avail: CASI HC A02/MF A01

In the last three years, many papers dealing with the preparation and biological activity of compounds that act as allosteric effectors of hemoglobin have been published. Among the numerous moieties, some urea derivatives were found to be very effective in reducing oxygen affinity of hemoglobin. The structures of most of the compounds were confirmed by H-1 NMR spectra; however, to our knowledge, C-13 NMR spectra have not been published for any of these allosteric modifiers of hemoglobin. We prepared in this series over 30 new urea and thiourea derivatives with the intent of investigating their biological activity. An analysis of C-13 NMR spectra revealed high regularity in the chemical shifts of the similar fragments of the structures and revealed signal deviations among structures having different substituents in the aromatic rings. DTIC

N93-28306# Federal Aviation Administration, Washington, DC. Office of Aviation Medicine.
INDEX OF INTERNATIONAL PUBLICATIONS IN AEROSPACE MEDICINE Final Report
MELCHOR J. ANTUNANO Feb. 1993 26 p
(AD-A262908; DOT/FAA/AM-93/3) Avail: CASI HC A03/MF A01

The Index of International Publications in Aerospace Medicine is a comprehensive listing of international publications in clinical aerospace medicine, operational aerospace medicine, aerospace physiology, environmental medicine/physiology, diving medicine/physiology, aerospace human factors, as well as other important topics directly- or indirectly-related to aerospace medicine. The Index is divided into six major sections: (1) Open Publications in General Aerospace Medicine; (2) Government Publications in General Aerospace Medicine; (3) Publications in other Topics related to Aerospace Medicine; (4) Proceedings from Scientific Meetings, Conferences, and Symposiums in Aerospace Medicine; (5) Journals, Newsletters, and Bulletins in Aerospace Medicine; and (6) Online Computerized Databases containing Bibliographic Information in Aerospace Medicine and Related Disciplines. DTIC

N93-28469# Technische Univ., Berlin (Germany). Fachbereich Informatik.
DOKMA: A DOCUMENT ORIENTED COMMUNICATION MODEL FOR MEDICAL APPLICATIONS AS A BASIS OF A ROLE SYSTEM IN THE MEDICAL FIELD Ph.D. Thesis [DOKMA: EIN DOKUMENTENORIENTIERTES KOMMUNIKATIONSMODELL FUER MEDIZINISCHE ANWENDUNGEN ALS BASIS FUER EIN ROLLENSYSTEM IM MEDIZINISCHEN UMFELD]
CHRISTIAN GAYDA 1992 248 p In GERMAN
(ETN-93-93799) Avail: CASI HC A11/MF A03

Starting with an abstract communication model that examines communication aspects in general, the document oriented communication model for medical applications is developed. It relies on a transfer model. The requirements towards this transfer model are defined by means of the document oriented communication model for medical applications. The communication model itself has to fulfill three requirements. A specification phase has to be supported by this model. Furthermore, it should constitute a kind of reference model for discussion purposes and it must support a verification phase. In order to reach these goals within the communication model for medical applications, the related problems concerning document oriented communication are assigned to layers that are put in relation to each other. The integration and communication of patient data by means of computers imply special requirements on data security. Therefore, the document oriented communication model for medical applications takes these aspects into consideration within a security of roles. A second goal of this model is to support the flow of documents. The description of the role model and its implementation (the role system) constitutes the second focal point of this thesis. ESA

N93-28739*# Aerospace Medical Research Labs., Wright-Patterson AFB, OH. Visual Display Systems Branch.
ARMSTRONG LABORATORY SPACE VISUAL FUNCTION TESTER PROGRAM
MELVIN R. ONEAL, H. LEE TASK, and GERALD A. GLEASON *In* NASA, Washington, NASA/DOD Flight Experiments Technical Interchange Meeting Proceedings 6 p 1992
Avail: CASI HC A02/MF A10

Viewgraphs on space visual function tester program are presented. Many astronauts and cosmonauts have commented on apparent changes in their vision while on-orbit. Comments have included descriptions of earth features and objects that would suggest enhanced distance visual acuity. In contrast, some cosmonaut observations suggest a slight loss in their object discrimination during initial space flight. Astronauts have also mentioned a decreased near vision capability that did not recover to normal until return to earth. Duntley space vision experiment, USSR space vision experiments, and visual function testers are described. Derived from text

N93-28740*# Aerospace Medical Research Labs., Wright-Patterson AFB, OH. Visual Display Systems Branch.
EFFECT OF MICROGRAVITY ON SEVERAL VISUAL FUNCTIONS DURING STS SHUTTLE MISSIONS: VISUAL FUNCTION TESTER-MODEL 1 (VFT-1)
MELVIN R. ONEAL, H. LEE TASK, and LOUIS V. GENCO *In* NASA, Washington, NASA/DOD Flight Experiments Technical Interchange Meeting Proceedings 14 p 1992
Avail: CASI HC A03/MF A10

Viewgraphs on the effect of microgravity on several visual functions during STS shuttle missions are presented. The purpose, methods, results, and discussion are discussed. The visual function tester model 1 is used. CASI

N93-28741*# Aerospace Medical Research Labs., Wright-Patterson AFB, OH. Visual Display Systems Branch.
EFFECT OF MICROGRAVITY ON VISUAL CONTRAST THRESHOLD DURING STS SHUTTLE MISSIONS: VISUAL FUNCTION TESTER-MODEL 2 (VFT-2)
MELVIN R. ONEAL, H. LEE TASK, and LOUIS V. GENCO *In* NASA, Washington, NASA/DOD Flight Experiments Technical Interchange Meeting Proceedings 6 p 1992
Avail: CASI HC A02/MF A10

Viewgraphs on effect of microgravity on visual contrast threshold during STS shuttle missions are presented. The purpose, methods, and results are discussed. The visual function tester model 2 is used. CASI

N93-28742*# Aerospace Medical Research Labs., Wright-Patterson AFB, OH. Visual Display Systems Branch.
EFFECT OF MICROGRAVITY ON THE VISUAL NEAR POINT: VISUAL FUNCTION TESTER-MODEL 4 (VFT-4)
GERALD A. GLEASON, H. LEE TASK, and MELVIN R. ONEAL *In* NASA, Washington, NASA/DOD Flight Experiments Technical Interchange Meeting Proceedings 8 p 1992
Avail: CASI HC A02/MF A10

Viewgraphs on effect of microgravity on the visual near point are presented. Background, problem, objectives, approach, benefits, and status are discussed. The visual function tester model 4 is used. CASI

N93-28758# Chemical Warfare/Chemical and Biological Defense Information Analysis Center, Edgewood, MD.
EVALUATION AND OPTIMIZATION OF A FLEXIBLE FILTRATION SYSTEM FOR RESPIRATORY PROTECTION SYSTEM 21 Final Report
K. C. HOFACRE, R. L. MARKHAM, and V. M. NORTHRUP Feb.

1993 43 p
(Contract DLA900-86-C-2045)
(AD-A262467; CBIAC-SS-373) Avail: CASI HC A03/MF A01

Current filter elements for the M40 series of respirators are housed in rigid, metal canisters that contain media for aerosol filtration, and adsorption of gases or vapors. The filtration media is often pleated for increased surface area. Certain harmful gases are removed by adsorption to activated carbon that has been treated with hexavalent chromium or zinc metal cations in a process known as whetlerization. Whetlerization provides active sites to chemisorb certain poison gases. The carbon is generally present as a coarse granular bed, but can also be present in a powder form incorporated in a fabric, as in the M13A2 filter element.

DTIC

N93-28759# California Univ., San Diego, La Jolla. Dept. of Chemistry.

WOUND HEALING AND CONNECTIVE TISSUE METABOLISM: THE ROLE OF HYPERBARIC OXYGEN THERAPY Final Report, 1 Jul. 1991 - 30 Jun. 1992

ELVIN HARPER Jun. 1992 6 p
(Contract AF-AFOSR-0413-91)
(AD-A262483; AFOSR-93-0202TR) Avail: CASI HC A02/MF A01

The effect of hyperbaric oxygen on wound healing by the following growth promoting factors is discussed: Epidermal growth factor (EGF), platelet derived growth factor (PDGF), and transforming growth factor B (TGFB). These compounds are of particular interest since they have been reported to increase collagenase secretion. EGF when applied directly to skin increased the rate of healing by 100%.

DTIC

N93-28835# Department of Energy, Washington, DC. Medical Applications and Biophysical Research Div.

PROCEEDINGS OF A WORKSHOP ON MOLECULAR NUCLEAR MEDICINE

R. C. REBA, ed. 1992 161 p Workshop held in Washington, DC, 22-23 Jan. 1992
(DE93-010828; CONF-920113-7) Avail: CASI HC A08/MF A02

The Office of Health and Environmental Research (OHER) of the Department of Energy (DOE) has increased the emphasis on research in structural biology and molecular biology. The department has increased support substantially in the area of basic molecular and structural biology research. To exploit the advances in these fields, OHER has sought to apply those advances in their other areas of responsibility, e.g., health effects research, environmental biology, and, in particular, nuclear medicine. The applications of biotechnology have contributed greatly to the productive research efforts of molecular biology. These techniques include gene manipulation for targeted gene delivery; characterization of molecular probes for hormone, tumor, and neuroreceptors; the receptor-agonist/antagonist binding interactions; studies of mechanisms of cellular communication; and the development of in vitro diagnostics such as molecular probes for studying the aging process and patients with mental disorders, cancer, and atherosclerosis. The importance of this work is the reasonable expectation that mainly, through an appreciation of the molecular basis of disease, will the most effective and rapid progress be made toward understanding, identifying, solving, and preventing specific disease processes. Critical questions arising before and during the workshop are how the following technologies can be applied in a practical clinical research or patient management setting: the recombinant DNA methodology, the technology of engineered monoclonal antibodies, the new methods for protein production and purification, and the production of transgenic animals.

DOE

N93-28939# Defence and Civil Inst. of Environmental Medicine, Downsview (Ontario).

INFLUENCE OF THE COLD BUSTER (TM) SPORTS BAR ON HEAT DEBT, MOBILIZATION AND OXIDATION OF ENERGY SUBSTRATES

A. L. VALLERAND, I. F. SCHMEGNER, and I. JACOBS Dec. 1992 30 p
(AD-A262762; DCIEM-92-60) Avail: CASI HC A03/MF A01

In a recent study, we have shown that the commercially available Cold Buster(TM) Sports bar, purported to improve cold resistance, did not do so in our subjects exposed to a relatively severe cold test. One possible explanation for our conflicting results is that our metabolic rate (M) was too high for the possibly small thermogenic effect of the bar to be measurable. The goal of this study was therefore to re-evaluate, under milder conditions, the influence of the Cold Buster(TM) on heat balance (heat debt = heat production - heat losses) and body temperatures. Eight semi-nude fasted subjects were exposed to the cold (3h at rest, 10 C, less than 0.4 m/s wind) on two occasions following the ingestion of either a placebo (100 ml water) or a Cold Buster(TM) (all feedings at min 0 and 90). As a result of the cold, M, dry heat losses and heat debt (S) increased whereas mean skin temperature decreased (P less than 0.05). Rectal temperature remained unchanged due to the mild cold. In all of the above parameters, there were no differences between treatments. Ingestion of the Colt Buster(TM) significantly increased carbohydrate oxidation compared to the placebo. However, this was without impact on M, since it occurred entirely at the expense of fat oxidation. Interestingly, the Cold Buster(TM) increased plasma glucose and insulin levels 2h into the cold. This secretion of insulin seems to have blunted lipid mobilization since it significatly reduced plasma free fatty acids levels. The result confirm previous data where the ingestion of the Cold Buster(TM) Sports bar did not alter heat production, heat losses, heat debt or even body temperatures, and extended these observations to a mild cold stress.

DTIC

N93-29041*# Mount Sinai School of Medicine, New York, NY. Dept. of Neurology.

NASA SUPPORTING STUDIES FOR MICROGRAVITY RESEARCH ON EYE MOVEMENTS Final Technical Report, 1 Jan. - 31 Dec. 1990

BERNARD COHEN 31 Dec. 1990 6 p
(Contract NAGW-1998)
(NASA-CR-193233; NAS 1.26:193233) Avail: CASI HC A02/MF A01

The purpose of the work on this project was to provide support for ground-based studies on the effects of gravity on eye movements. The effects of microgravity on the optokinetic eye movements of humans are investigated. OKN was induced by having subjects watch 3.3 deg stripes moving at 35 deg/s for 45 s in a binocular, head-fixed apparatus. The field (hor., 88 deg; vert., 72 deg), was rotated about axes that were upright or tilted 45 deg or 90 deg. The head was upright or tilted 45 deg on the body. Head-horizontal (yaw axis) and head-vertical (pitch axis) components of OKN were recorded with electro-oculography (EOG). Slow phase velocity vectors were determined relative to gravity. With the head upright, the axis of eye rotation during yaw axis OKN was coincident with the stimulus axis and the spatial vertical. With the head tilted 45 deg on the body, a persistent vertical component of eye velocity developed during yaw axis stimulation, and there was an average shift of the axis of eye rotation toward the spatial vertical of approximately 18 deg in six subjects. During oblique optokinetic stimulation with the head upright, the axis of eye rotation shifted 12 deg toward the spatial vertical. When the head was tilted, the axis of eye rotation rotated to the other side of the spatial vertical by 5.4 deg during the same oblique stimulation. This counter-rotation of the axis of eye rotation is similar to the 'Muller (E) effect', in which the perception of the upright counter-rotates to the opposite side of the spatial vertical when subjects are tilted in darkness. The data were simulated by a model of OKN. Despite the short OKAN time constants, strong horizontal to vertical cross-coupling was produced if the horizontal and vertical time constants were in proper ratio, and there was no suppression of nystagmus orthogonal to the stimulus direction. This shows that the spatial orientation of OKN can be due to a restructuring of the system matrix of velocity storage as a function of gravity. It is concluded that although

human OKAN is weak, velocity storage orients the slow phase velocity of OKN towards the spatial vertical. Author (revised)

N93-29199# Utah Univ., Salt Lake City. Ergonomics Lab.
SUDDEN LOADING AND FATIGUE EFFECTS ON THE HUMAN SPINE Final Report
DANIEL R. BAKER and DONALD S. BLOSWICK 16 Nov. 1992 54 p
(Contract PHS-R03-OH0-2821-01)
(PB93-167526) Avail: CASI HC A04/MF A01

The effects of fatigue and load magnitude on the in vivo torso response of human subjects to a sudden load were analyzed in six individuals. Parameter identification of the human spine was performed within a sudden loading, short duration, high intensity fatigue paradigm. The findings indicated that fatigue is an important factor under conditions of sudden loading. The fatigued subject does not respond in the same way as he does when not tired. It is suggested that a higher degree of injury would be expected under conditions of fatigue. Most of the time the worker is not at the point of fatigue, and performance of certain tasks is usually practiced under conditions which are better than those prevalent under conditions of fatigue. Two reports are being produced from the data gathered in the study. The first will examine the electromyographic responses of the individual and compare them to the dynamics of the torso. The second study will mathematically study the compression levels expected as a result of earlier work. The authors suggest that their most important finding was the ability to mathematically model a complex response of the torso to a sudden load with a simple second order linear model. The study demonstrated that short duration, high intensity muscular fatigue changes the way in which the torso responds to a sudden load. NTIS

53

BEHAVIORAL SCIENCES

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

A93-39571 National Aeronautics and Space Administration, Washington, DC.
PERFORMANCE CONSEQUENCES OF AUTOMATION-INDUCED 'COMPLACENCY'
RAJA PARASURAMAN, ROBERT MOLLOY, and INDRAMANI L. SINGH (Catholic Univ. of America, Washington) International Journal of Aviation Psychology (ISSN 1050-8414) vol. 3, no. 1 1993 p. 1-23. refs
(Contract NAGW-17; NAG1-1296)
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The effect of variations in the reliability of an automated monitoring system on human operator detection of automation failures was examined in two experiments. For four 30-min sessions, 40 subjects performed an IBM PC-based flight simulation that included manual tracking and fuel-management tasks, as well as a system-monitoring task that was under automation control. Automation reliability - the percentage of system malfunctions detected by the automation routine - either remained constant at a low or high level over time or alternated every 10 min from low to high. Operator detection of automation failures was substantially worse for constant-reliability than for variable-reliability automation after about 20 min under automation control, indicating that the former condition induced 'complacency'. When system monitoring was the only task, detection was very efficient and was unaffected by variations in automation reliability. The results provide the first empirical evidence of the performance consequences of automation-induced 'complacency'. We relate findings to operator attitudes toward automation and discuss implications for cockpit automation design. Author

A93-39572
STRUCTURED INTERVIEWS FOR PILOT SELECTION - NO INCREMENTAL VALIDITY
LAURIE C. WALTERS, MARK R. MILLER, and MALCOLM J. REE (USAF, Armstrong Lab., Brooks AFB, TX) International Journal of Aviation Psychology (ISSN 1050-8414) vol. 3, no. 1 1993 p. 25-38. refs
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An investigation of a structured interview for the selection of U.S. Air Force pilots was conducted on a sample of 223 pilot trainees. The interview yielded seven ratings of subject attributes, including educational background, self-confidence and leadership, flying motivation, success in training, and success in flying various classes of aircraft. Two other types of predictors were also available - paper-and-pencil aptitude tests and computer-driven cognitive tests of information processing and personality. Using linear models, the validity and incremental validity of the interview as compared to the other classes of tests were evaluated. The interview was found to be valid but not incrementally so. Last, a partial test of a single aspect of the Dipboye (1989) process model of interviews was conducted. Author

A93-39575
INCREASING HITS AND REDUCING MISSES IN CRM/LOS SCENARIOS - GUIDELINES FOR SIMULATOR SCENARIO DEVELOPMENT
CAROLYN PRINCE, RANDALL OSER, EDUARDO SALAS (U.S. Navy, Naval Training Systems Center, Orlando, FL), and WALTER WOODRUFF (USAF, Orlando, FL) International Journal of Aviation Psychology (ISSN 1050-8414) vol. 3, no. 1 1993 p. 69-82. refs
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Simulator scenarios have been used to elicit aircrew members' skills for research, training, and evaluation. These scenarios are associated with line-operational simulations, line-oriented flight training, line-operational evaluation, and special-purpose operational training. Design guidelines for these scenarios have been published in Federal Aviation Administration (1990) Advisory Circular 120-35B and in the National Aeronautics and Space Administration Guidelines for the Development of Line-Oriented Flight Training (Lauber & Foushee, 1981). Although these two publications include the essential information for scenario development, there is additional guidance needed by individuals who are inexperienced in scenario design to help ensure that their scenarios will have value for their intended purpose. Based on experience in developing scenarios for research and training, with a primary focus on crew resource management (CRM) behaviors, U.S. Navy researchers have now augmented existing guidelines for scenario development. These guidelines, with an emphasis on their use for CRM training, are presented to assist others who design scenarios. Author

A93-39708
INFLUENCE OF AGING AND PRACTICE ON PILOTING TASKS
D. MORROW, J. YESAVAGE, V. LEIRER, and J. TINKLENBERG (Stanford Univ., CA) Experimental Aging Research (ISSN 0361-073X) vol. 19, no. 1 Jan.-Mar. 1993 p. 53-70.
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We examined how pilot age influences radio communication and routine flying tasks during simulated flight, and if practice reduces age differences in these tasks. The communication task involved reading back and executing messages with four commands (heading, altitude, communication frequency, transponder code). Routine flying tasks included takeoff, visual approach, and landing. Fifteen older ($X = 38.4$ years) and 16 younger ($X = 26.1$ years) private-license pilots flew 12 flights involving these tasks. Age differences were found in the communication task; older pilots read back and executed controller messages less accurately. However, age differences were not significant for any of the routine flying tasks except the approach. Age differences in communication performance were not reduced by practice, with older and young pilots improving at roughly the same rate across flights. These results are consistent with previous research showing age-related

declines in working memory capacity. Capacity declines would produce greater age differences on communication than on routine flying tasks because the communication tasks imposed a greater load on working memory. Author

A93-40771
COGNITIVE PREDICTORS OF VIGILANCE
GERALD MATTHEWS (Dundee Univ., United Kingdom), D. R. DAVIES, and PETER J. HOLLEY (Aston Univ., Birmingham, United Kingdom) Human Factors (ISSN 0018-7208) vol. 35, no. 1 March 1993 p. 3-24. Research supported by Medical Research Council refs
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Three studies are reported of individual differences in performance of high event rate vigilance tasks. In each study, measures of attentional resource availability and elementary cognitive components of sustained attention were correlated with vigilance performance. It was predicted that correlates of vigilance should vary with two parameters of the task: the type of target discrimination required (simultaneous or successive) and the type of stimuli used (sensory or symbolic). Speed and accuracy of controlled, resource-demanding visual search predicted overall perceptual sensitivity on three out of four successive tasks used, but only one out of four simultaneous tasks, partially confirming the hypothesis that successive tasks are more strongly resource-limited than simultaneous tasks. Other correlates of overall level vigilance did not appear to vary systematically with task parameters. Few correlates of temporal decrement in perceptual sensitivity were found, possibly for statistical reasons. The data suggest that measures of controlled search may be useful in predicting vigilance on certain real-world tasks, although a substantial part of the variance of vigilance tasks may not be predictable from short cognitive tasks. Author

A93-40772* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PERFORMANCE UNDER DICHOPTIC VERSUS BINOCULAR VIEWING CONDITIONS - EFFECTS OF ATTENTION AND TASK REQUIREMENTS
RUTH KIMCHI (Haifa Univ., Israel), DANIEL GOPHER, YIFAT RUBIN, and DAVID RAIJ (Technion - Israel Inst. of Technology, Haifa) Human Factors (ISSN 0018-7208) vol. 35, no. 1 March 1993 p. 35-55. Research supported by NASA refs
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Three experiments investigated subjects' ability to allocate attention and cope with task requirements under dichoptic versus binocular viewing conditions. Experiments 1 and 2 employed a target detection task in compound and noncompound stimuli, and Experiment 3 employed a relative-proximity judgment task. The tasks were performed in a focused attention condition in which subjects had to attend to the stimulus presented to one eye or field (under dichoptic and binocular viewing conditions, respectively) while ignoring the stimulus presented to the other eye or field, and in a divided attention condition in which subjects had to attend to the stimuli presented to both eyes or fields. Subjects' performance was affected by the interaction of attention conditions with task requirements, but it was generally the same under dichoptic and binocular viewing conditions. The more dependent the task was on finer discrimination, the more performance was impaired by divided attention. These results suggest that at least with discrete tasks and relatively short exposure durations, performance when each eye is presented with a separate stimulus is the same as when the entire field of stimulation is viewed by both eyes. Author

A93-41166
DYNAMIC ANALYSIS OF HUMAN VISUO-OCULO-MANUAL *COORDINATION CONTROL IN TARGET TRACKING TASKS*
JEAN-LOUIS VERCHER, MICHEL VOLLE, and GABRIEL M. GAUTHIER (Aix-Marseille I, Univ., Marseille, France) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 6 June 1993 p. 500-506. Research supported by CNRS, EEC, and Univ. de Quebec refs
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Human subjects tracked a visual target controlled either by a function generator (sine wave at different frequencies) or directly by the observer's arm. Gain and phase curves of the oculomotor response as a function of target frequency were determined. Data show that the upper frequency limit of smooth pursuit is higher when the target is driven by the observer's hand, confirming previous reports that smooth pursuit can reach higher velocities when tracking self-moved targets. Comparative analysis of ocular tracking with and without manual target control showed that subjects could be classified into two groups. One group exhibited an increase in gain at high frequency, but showed no significant phase changes. Conversely, the reverse was found in the other group: a significant decrease of phase lag at high frequency and no change in gain. These results demonstrate the existence, within the oculo-manual coordination control system, of at least two separate mechanisms (or strategies), tending either to synchronize the eye and arm motor activities (timing coordination) or to adjust their gain (spatial coordination). Author

A93-41322
A STUDY OF DECISION MAKING AND PERFORMANCE IN REJECTED TAKEOFFS
WILLIAM C. ROBERSON and WILLIAM D. SHONTZ (Boeing Commercial Airplane Group, Seattle, WA) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921134) Copyright

A study was conducted in a B-737 full flight simulator at the Boeing Customer Training facility to evaluate pilot decision making and performance under various situations in which decisions on whether or not to reject a take off had to be made and executed. A total of eight (8) situations were defined in which Go/NoGo decisions had to be made near V1 speed. Subjects included 24 Boeing instructor pilots and 24 line pilots from five different airlines. The sequence in which pilots encountered the situations was carefully balanced across subjects to control for learning effects. The results of the study are reported as quantitative data on RTO decisions, stopping performance, and procedure accomplishment plus a summary of data derived from post-run debriefings of the airline pilots. Lessons learned, conclusions, and recommendations for RTO training are presented. Author

A93-41324* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
IDENTIFICATION OF HAZARDOUS AWARENESS STATES IN MONITORING ENVIRONMENTS
ALAN T. POPE (NASA, Langley Research Center, Hampton, VA) and EDWARD H. BOGART (Lockheed Engineering & Sciences Co., Hampton, VA) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921136) Copyright

A state identification procedure and a model for predicting aerospace crew/system combinations that interact to produce hazardous states are described. This procedure in conjunction with the model provide a capability for evaluating the design of advanced flight deck automation concepts based on the pilot's ability to maintain effective states of awareness. The model describes individual and situational factors that affect the likelihood that persons in operational settings will experience hazardous states of awareness. AIAA

A93-41369
THE PSYCHOLOGICAL EFFECTS OF ISOLATION ON A SPACE STATION - A SIMULATION STUDY
RAGNAR J. VAERNES, TONE BERGAN, HOLGER URSIN, and MARIT WARNCKE (Norwegian Underwater Technology Centre; Bergen Univ., Norway) Jul. 1992 12 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921191) Copyright

Psychological experiments conducted within the framework of an Isolation Study for European Manned Space Infrastructure are described. Six subjects were locked up in NUTEC's hyperbaric chamber facility for a period of four weeks. Results show that simple performance such as reaction time and vigilance were unaffected during the isolation. The more complicated mental strategies showed some temporal changes throughout the 28 days. The perceived workload indicated that the overall load was emotionally, cognitively, and physically in the middle range, even though the actual working hours were up to 12 hours. AIAA

N93-27103# Advanced Aviation Concepts, Jupiter, FL.
HOW EXPERT PILOTS THINK: COGNITIVE PROCESSES IN EXPERT DECISION MAKING Final Report
RICHARD J. ADAMS Feb. 1993 82 p Sponsored by DOT/FAA Research and Development Service, Washington, DC
(Contract DTFA01-90-C-00042)
(DOT/FAA/RD-93/9) Avail: CASI HC A05/MF A01

This report is the second in the investigation of the role of expert cognitive processes in Aeronautical Decision Making (ADM). The first report defined the differences between expert and novice decision makers and correlated the development of expert pilot cognitive processes with training and experience. This volume continues the research into the understanding of how pilots think by examining human information processing and expert problem solving characteristics. From this analysis, the mental attributes critical to developing expert decision making are explained, and three basic limits on decision making are identified. These are attention span, short term memory, and long term memory. Next, the analysis examines the development of Expert Decision Making (EDM) from the comparison of how novices and experts perceive, store, organize and use their knowledge. This analysis shows that high levels of competence result from the interaction between knowledge organization and processing abilities. Experts are found to possess the abilities of rapid access to, and efficient utilization of a highly organized body of conceptual and procedural knowledge. That is, an elaborately structured set of associated concepts, procedures and events--based upon many years of study, training, and experience in a aviation. The use of this knowledge base is described in terms of the characteristics of EDM related to perception, attention, memory, creativity, and superior situational awareness. Since the speed and accuracy of expert cognitive processes make them take on the characteristics of insight or intuition, the role of intuition in decision making is the next analytical part of the investigation. Intuition is defined and the properties of intuition relevant to EDM delineated. Finally, the report concludes by presenting alternative EDM training opportunities including: training to enhance memory, computer based training tools, and promising methods for testing pilots which will also provide training and the opportunity to learn the cognitive skills of experts without spending all of the learning time in actual flight. Author

N93-28128*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
METHOD OF ENCOURAGING ATTENTION BY CORRELATING VIDEO GAME DIFFICULTY WITH ATTENTION LEVEL Patent Application
ALAN T. POPE, inventor (to NASA) and EDWARD H. BOGART, inventor (to NASA) (Lockheed Engineering and Sciences Co., Hampton, VA.) 8 Mar. 1993 37 p
(NASA-CASE-LAR-15022-1; NAS 1.71:LAR-15022-1; US-PATENT-APPL-SN-029808) Avail: CASI HC A03/MF A01

A method of encouraging attention in persons such as those suffering from Attention Deficit Disorder is provided by correlating the level of difficulty of a video game with the level of attention in a subject. A conventional video game comprises a video display which depicts objects for interaction with a player and a difficulty adjuster which increases the difficulty level, e.g., action speed and/or evasiveness of the depicted object, in a predetermined manner. The electrical activity of the brain is measured at selected sites to determine levels of awareness, e.g., activity in the beta, theta, and alpha states. A value is generated based on this measured electrical signal which is indicative of the level of awareness. The difficulty level of the game is increased as the awareness level value decreases and is decreased as this awareness level value increases. NASA

N93-28307# Aerospace Medical Research Labs., Wright-Patterson AFB, OH.
THEORY OF SIGNAL DETECTION AND ITS APPLICATION TO VISUAL TARGET ACQUISITION: A REVIEW OF THE LITERATURE Final Report, Oct. 1991 - May 1992
DENISE L. WILSON May 1992 56 p
(AD-A262920; AL-TR-1992-0083) Avail: CASI HC A04/MF A01

An operator's performance in a target acquisition task may be influenced by variables which are not directly associated with the target and imagery but are associated with the decision rule employed by the operator. The separation of factors that influence the operator's decision criterion from those that influence sensitivity is a major contribution of the psychophysical application of the Theory of Signal Detection (TSD). This report focuses on practical application of TSD to the problem of operator acquisition of targets in sensor imagery which ray, or may not, have been prescreened by an automatic target recognizer. The foundation of TSD in Statistical Decision Theory is discussed as well as specific methods for applying TSD to laboratory evaluation of the target acquisition task. A brief review is presented of target acquisition studies in which TSD was utilized. DTIC

N93-28622# Civil Aeromedical Inst., Oklahoma City, OK.
ACCIDENT PRONENESS: A RESEARCH REVIEW Final Report
MARK D. RODGERS and ROBERT E. BLANCHARD May 1993 6 p
(DOT/FAA/AM-93/9) Avail: CASI HC A02/MF A01

Accident proneness is a concept that refers to an enduring or stable personality characteristic that predisposes an individual toward having accidents. The concept is controversial and has sustained a lively debate in the literature over the past 75 years. For the most part, though, continual interest has been fueled by poor experimental procedures, misinterpretation of previously reported results, the need to assign blame to individuals, and a rather curious doggedness in attempting to establish a relationship between accidents and personality traits, despite the lack of supporting scientific evidence. The origins of the notion of accident proneness are reported and the studies that purport to support or refute it are reviewed. Author (revised)

N93-28901# Georgia Univ., Athens. Dept. of Psychology.
EXPERTISE, TEXT COHERENCE, AND CONSTRAINT SATISFACTION: EFFECTS ON HARMONY AND SETTLING RATE Quarterly Report
BRUCE K. BRITTON and F. J. EISENHART 8 Mar. 1993 10 p
(AD-A262703) Avail: CASI HC A02/MF A01

This paper reports four experiments showing that 27 experts' mental representations had significantly higher harmony and faster settling rates than 652 novices when activation was spread through the representations in a simulation of thinking; that when coherent texts were read by novices, they produced mental representations with significantly higher harmony and faster settling rates than less coherent texts; and that novices whose representations matched the experts' mental representations had significantly higher harmony and faster settling rates. The results were found for declarative experts in history and procedural experts in literary interpretation, for Dutch and American experts, for novice groups including U.S. Air Force recruits and U.S. and Dutch undergraduates, and for both history texts and literary texts. These results were consistent with our hypothesis that the quality of a person's prior knowledge determines the harmony and settling rates of their representations and that these can be measured by simulating the spread of activation through the person's mental representation of a subject matter domain. Harmony may also be used as a metacognitive signal. DTIC

54

MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

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

A93-39573
AN EXPLORATORY STUDY OF PLAN-VIEW TERRAIN DISPLAYS FOR AIR CARRIER OPERATIONS
JAMES K. KUCHAR and R. J. HANSMAN, JR. (MIT, Cambridge, MA) International Journal of Aviation Psychology (ISSN 1050-8414) vol. 3, no. 1 1993 p. 39-54. refs
(Contract DTRS-57-88-C-00078)
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Two prototypical terrain situational awareness (TSA) displays were examined in a preliminary part-task simulation study using the MIT Aeronautical Systems Laboratory Advanced Cockpit Simulator. Pilots, qualified on autoflight aircraft, flew simulated approaches while using a moving-map terrain display in addition to typical glass-cockpit navigation displays. During the simulation, TSA was evaluated by issuing erroneous air traffic control (ATC) vectors toward hazardous terrain. When given vectors toward such terrain, there was a 50 percent overall hazard-recognition rate when pilots used a terrain display based on current terrain-depiction methods and a 78 percent recognition rate when using a terrain display based on smoothed-contour terrain depiction. After the subject-pilots realized they could not rely on ATC for terrain separation, hazard-recognition rates increased from 20 percent to 62 percent for the display based on current depiction methods and from 25 percent to 93 percent for the smoothed-contour display. Advanced terrain displays appear to be an effective means by which flight crews can ensure terrain separation without reliance on ATC. Author

A93-39574
INSTRUMENT-APPROACH-PLATE DESIGN CONSIDERATIONS FOR DISPLAYING RADIO FREQUENCIES
JORDAN MULTER, ROBERT DISARIO, M. S. HUNTLEY, JR. (DOT, National Transportation Systems Center, Cambridge, MA), and MARGARET WARNER (EG&G Dynatrend, Inc., Cambridge, MA) International Journal of Aviation Psychology (ISSN 1050-8414) vol. 3, no. 1 1993 p. 55-68. Research supported by FAA refs
Copyright

This experiment examined the effectiveness of four different layouts for displaying radio frequencies on instrument approach plates. Three of the four layouts were similar to those found in existing charts published by the National Oceanic and Atmospheric Administration (NOAA), Jeppesen Sanderson, Inc., and the Canadian Department of Energy, Mines, and Resources. The fourth layout was a two-column format not currently found on existing charts. Subjects' performance with the two column and boxed layouts was found to be superior to that of subjects' performance with the one-column layouts representative of NOAA and Jeppesen charts. Author

A93-41172
CONTACT LENSES IN AVIATION - THE MARINE CORPS EXPERIENCE
MICHAEL H. MITTELMAN, BRIAN SIEGEL, and DAVID L. STILL (U.S. Navy, Naval Aerospace Medical Inst., Pensacola, FL) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 6 June 1993 p. 538-540. refs
Copyright

Application of contact lenses in the unique U.S. Marine Corps aviation environment which encompasses shipboard, land-based, and forwardly deployed units, was evaluated in 90 pilots focusing on flex-wear disposable lenses. Results revealed that 68 pilots were successfully fit and continued contact lens wear for a period of 16 months. Safety and health were not compromised and job performance was favorably affected. AIAA

A93-41173
PREVALENCE OF CORRECTIVE LENS WEAR IN ROYAL AUSTRALIAN AIR FORCE FLIGHT CREWS
MICHAEL R. MORK and LAURANCE A. WATSON (USAF, Aerospace Medicine Div., Hickam AFB, HI) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 6 June 1993 p. 541-545. refs
Copyright

The effect of restrictive entry visual standards for the Royal Australian Air Force (RAAF) on the prevalence of corrective lens wear in its aircrew were studied. Entry visual refraction standards for the RAAF and USAF were compared. It is found that the RAAF's standards for entry into aircrew training programs significantly reduced the prevalence of corrective lens wear among all crew positions when compared to the USAF. AIAA

A93-41174
NEW TECHNOLOGIES FOR IN-FLIGHT PASTELESS BIOELECTRODES
DAVID PRUTCHI (Tel Aviv Univ., Israel) and ALYSIA M. SAGI-DOLEV (Israeli Air Force, Aeromedical Center, Ramat Gan, Israel) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 6 June 1993 p. 552-556. Research supported by Tel Aviv Univ refs
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Advances in development of in-flight electrophysiological based systems such as G-LOC detectors, ECG-synchronized G-suits, and clinical monitors have dictated the need for pasteless electrodes that meet realistic operational demands and are suitable for the cockpit environment. New technologies appropriate for the design of bioelectrodes that meet these demands are described, including a stable dielectric electrode-skin interface material, miniaturized high-impedance electronics, and circuit fabrication methods. Design examples and resulting electrophysiological recordings are presented to demonstrate the new technologies. Author

A93-41175
SIMULATING REDUCED GRAVITY - A REVIEW OF BIOMECHANICAL ISSUES PERTAINING TO HUMAN LOCOMOTION
BRIAN L. DAVIS (Pennsylvania State Univ., University Park; Cleveland Clinic Foundation, Dept. of Biomedical Engineering and Applied Therapeutics, OH) and P. R. CAVANAGH (Pennsylvania State Univ., University Park) Aviation, Space, and Environmental Medicine (ISSN 0095-6562) vol. 64, no. 6 June 1993 p. 557-566. refs
Copyright

Findings in neuromuscular and biomechanical issues in the context of human locomotion research are reviewed. The research was based on water immersion, parabolic aircraft flights, supine and erect cable suspension, and centrifugal methods. Data obtained indicate that the present shuttle treadmill running surface would not suffice for its operation at levels greater than 0.6 G. To replicate typical ground reaction force profiles during locomoter exercise at reduced gravity levels it is easier to match the peak rates of the force change than to match values of the peak force magnitudes. AIAA

A93-41306
SPACE STATION WATER PROCESSOR - CURRENT FLIGHT DESIGN
ALBERT M. BOEHM, ARTHUR K. COLLING, JR., MICHAEL J. HELDMANN, JOHN W. STEELE (Hamilton Standard, Windsor Locks, CT), and R. G. SHAW (Boeing Defense & Space Group, Seattle, WA) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 (SAE PAPER 921112) Copyright

An updated version of a Water Processor (WP) system which combines a Potable Water Processor and a Hygiene Water Processor is presented. The WP system is aimed at processing

the waste hygiene, handwash, and laundry waters, the temperature and humidity control condensate, Shuttle fuel cell water, and the urine distillate, to produce potable quality water. The WP major functions include waste water collection and storage, processed water storage and delivery, contaminant removal, and microbial separation between the waste and processed water. Key components of the WP encompass an inlet water separator that removes the free gas that is mixed with the inlet waste water, a high temperature sterilizer, particulate filters, multifiltration beds, and the volatile removal apparatus. AIAA

A93-41307
AN UPDATE ON THE READINESS OF VAPOR COMPRESSION DISTILLATION FOR SPACECRAFT WASTEWATER PROCESSING
LAWRENCE D. NOBLE, JR., FRANZ H. SCHUBERT, and ROBERT P. WERNER (Life Systems, Inc., Cleveland, OH) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921114) Copyright

An account is given of the development status of the NASA-Space Station Freedom Urine Processor Assembly (UPA), which employs a vapor compression distillation cycle. Recent design efforts have concentrated on the systems's Orbital-Replacement Units, giving attention to process control loops, fault-detection, and fault isolation. The UPA's performance capabilities show it to be the most mature of available systems for both orbital and interplanetary spacecraft. AIAA

A93-41309* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
PHASE III INTEGRATED WATER RECOVERY TESTING AT MSFC - CLOSED HYGIENE AND POTABLE LOOP TEST RESULTS AND LESSON LEARNED
DONALD W. HOLDER, JR. and ROBERT M. BAGDIGIAN (NASA, Marshall Space Flight Center, Huntsville, AL) Jul. 1992 16 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921117) Copyright

A series of tests has been conducted at the NASA Marshall Space Flight Center (MSFC) to evaluate the performance of a Space Station Freedom (SSF) pre-development water recovery system. Potable, hygiene, and urine reclamation subsystems were integrated with end-use equipment items and successfully operated for a total of 35 days, including 23 days in closed-loop mode with man-in-the-loop. Although several significant subsystem physical anomalies were encountered, reclaimed potable and hygiene water routinely met current SSF water quality specifications. This paper summarizes the test objectives, system design, test activities/protocols, significant results/anomalies, and major lessons learned. Author

A93-41310 National Aeronautics and Space Administration, Washington, DC.
OVERVIEW OF NASA'S 1991 LIFE SUPPORT SYSTEMS ANALYSIS WORKSHOP
PEGGY L. EVANICH (NASA, Washington), P. K. SESHAN (JPL, Pasadena, CA), CHIN LIN (NASA, Johnson Space Center, Houston, TX), VINCENT BILARDO (NASA, Ames Research Center, Moffett Field, CA), and THOMAS M. CRABB (Orbital Technologies Corp., Madison, WI) Jul. 1992 13 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992
(SAE PAPER 921118) Copyright

Results from the first NASA Life Support Systems Analysis Workshop conducted by the Office of Aeronautics and Space Technology on June 24-27, 1991, in Milwaukee, Wisconsin are reviewed. Attention is also given to a brief review of the second workshop held on May 12-14, 1992. It is noted that the workshops defined the key issues and characterized the status of current developments in life support systems analysis. AIAA

A93-41311* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
HUMAN LIFE SUPPORT DURING INTERPLANETARY TRAVEL AND DOMICILE. V - MARS EXPEDITION TECHNOLOGY TRADE STUDY FOR SOLID WASTE MANAGEMENT
JOE FERRALL, NARESH K. ROHATGI, and P. K. SESHAN (JPL, Pasadena, CA) Jul. 1992 20 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921119) Copyright

A model has been developed for NASA to quantitatively compare and select life support systems and technology options. The model consists of a modular, top-down hierarchical breakdown of the life support system into subsystems, and further breakdown of subsystems into functional elements representing individual processing technologies. This paper includes the technology trades for a Mars mission, using solid waste treatment technologies to recover water from selected liquid and solid waste streams. Technologies include freeze drying, thermal drying, wet oxidation, combustion, and supercritical-water oxidation. The use of these technologies does not have any significant advantages with respect to weight; however, significant power penalties are incurred. A benefit is the ability to convert hazardous waste into a useful resource, namely water. Author (revised)

A93-41312* Jet Propulsion Lab., California Inst. of Tech., Pasadena.
HUMAN LIFE SUPPORT DURING INTERPLANETARY TRAVEL AND DOMICILE. VI - GENERIC MODULAR FLOW SCHEMATIC FOR HYBRID PHYSICAL/CHEMICAL-BIOLOGICAL LIFE SUPPORT SYSTEMS
GANI B. GANAPATHI, P. K. SESHAN, JOSEPH FERRALL, and NARESH ROHATGI (JPL, Pasadena, CA) Jul. 1992 24 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921120) Copyright

An extension is proposed for the NASA Space Exploration Initiative's Generic Modular Flow Schematics for physical/chemical life support systems which involves the addition of biological processes. The new system architecture includes plant, microbial, and animal habitat, as well as the human habitat subsystem. Major Feedstock Production and Food Preparation and Packaging components have also been incorporated. Inedible plant, aquaculture, microbial, and animal solids are processed for recycling. AIAA

A93-41313* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
RECYCLING AND SOURCE REDUCTION FOR LONG DURATION SPACE HABITATION
T. M. HIGHTOWER (NASA, Ames Research Center, Moffett Field, CA) Jul. 1992 23 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921121) Copyright

A direct mathematical approach has been established for characterizing the performance of closed-loop life support systems. The understanding that this approach gives clearly illustrates the options available for increasing the performance of a life support system by changing various parameters. New terms are defined and utilized, such as Segregation Factor, Resource Recovery Efficiency, Overall Reclamation Efficiency, Resupply Reduction Factor, and Life Support Extension Factor. The effects of increases in expendable system supplies required due to increases in life support system complexity are shown. Minimizing resupply through increased recycling and source reduction is illustrated. The effects of recycling upon resupply launch cost is also shown. Finally, material balance analyses have been performed based on quantity and composition data for both supplies and wastes, to illustrate the use of this approach by comparing ten different closed-loop life support system cases. Author

A93-41314* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
ANALYSIS OF THE VARIABLE PRESSURE GROWTH CHAMBER USING THE CASE/A SIMULATION PACKAGE
CARL D. MCFADDEN (McDonnell Douglas Space Systems, Huntington Beach, CA) and MARYBETH A. EDEEN (NASA, Johnson Space Center, Houston, TX) Jul. 1992 12 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921122) Copyright

A computer simulation of the Variable Pressure Growth Chamber (VPGC), located at the NASA Johnson Space Center, has been developed using the Computer Aided Systems Engineering and Analysis (CASE/A) package. The model has been used to perform several analyses of the VPGC. The analyses consisted of a study of the effects of a human metabolic load on the VPGC and a study of two new configurations for the temperature and humidity control (THC) subsystem in the VPGC. The objective of the human load analysis was to study the effects of a human metabolic load on the air revitalization and THC subsystems. This included the effects on the quantity of carbon dioxide injected and oxygen removed from the chamber and the effects of the additional sensible and latent heat loads. The objective of the configuration analysis was to compare the two new THC configurations against the current THC configuration to determine which had the best performance. Author

A93-41315
TRIALSS - TOOL FOR RAPID AND INTELLIGENT ADVANCED LIFE SUPPORT SYSTEM SELECTION AND SIZING
SUSAN DOLL and BRIAN TILLOTSON (Boeing Defense & Space Group, Seattle, WA) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921123) Copyright

TRIALSS is a tool which makes use of modern software technology to assist in the life support systems (LSS) analysis process. TRIALSS has an icon-driven, user-friendly interface which allows the user to select from several physical/chemical LSS technologies. It displays power, mass, and volume at system, subsystem, and assembly levels. A unique feature of TRIALSS is the ability to easily vary mission parameters, including crew size, mission duration and location, power and thermal control system technologies, pressurized volume construction, and launch and transportation vehicle options. A powerful development environment, G2, allows the programmer to make rapid changes or additions and to incorporate rules to help the user avoid pitfalls. An example analysis for lunar applications shows the importance of mission context for system-level analysis, and demonstrates the utility of TRIALSS in enabling such analyses.
Author (revised)

A93-41316
A LOW PRESSURE ELECTROLYZER FOR THE NEXT GENERATION SUBMARINE
ANDREI LEONIDA, JAMES F. MCELROY, and ROGER N. SEXAUER (Hamilton Standard, Windsor Locks, CT) Jul. 1992 7 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992
(SAE PAPER 921125) Copyright

A low-pressure oxygen generation system for advanced submarine life support is presented which makes it possible to achieve significant cost savings. It is concluded that single cell performance at high differential pressure confirmed the feasibility of low pressure water electrolysis for a submarine oxygen generator. AIAA

A93-41317
BIOSPHERE 2 - OVERVIEW OF SYSTEM PERFORMANCE DURING THE FIRST NINE MONTHS
WILLIAM F. DEMPSTER (Space Biospheres Ventures, Oracle, AZ) Jul. 1992 7 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921129) Copyright

Biosphere 2 is a large closed ecological system occupied by eight human inhabitants in complete material isolation. It has been in operation continuously for 9 months of the initial 2 year run which commenced on Sept 26, 1991. The major areas of observation summarized in this paper are the dynamics of atmospheric composition, food production, health, quantification of leakage, plant growth, and species survival. Author

A93-41319
THE EFFECT OF GEOMETRIC FIELD OF VIEW AND TUNNEL DESIGN FOR PERSPECTIVE FLIGHT-PATH DISPLAYS
WOODROW BARFIELD and CRAIG ROSENBERG (Washington Univ., Seattle) Jul. 1992 8 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by Boeing Military Airplane Co. refs
(Contract NSF DMC-88-57851; NSF CDA-88-06866)
(SAE PAPER 921131) Copyright

Previous studies have shown that use of flight-path displays may lead to increased situational awareness during final approach and landing. However, there are a number of research issues which remain to be investigated concerning the optimum design of a perspective flight-path display. The purpose of this paper is to report the results of a study which investigated the relationship between the geometric field of view, number of tunnels in the display, and flight-path complexity on the subject's ability to fly a computer-simulated aircraft during final approach. Implications of the results for the design of perspective flight-path displays are discussed. Author

A93-41320
FLIGHT DECK AUTOMATION AND PILOT WORKLOAD
BARRY H. KANTOWITZ (Battelle Seattle Research Center, WA) Jul. 1992 8 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921132) Copyright

This article focuses upon some of the potential problems that can occur with 'glass cockpits', especially as they relate to pilot workload. The goal is not to condemn automation but to emphasize potential problems so that they can be avoided in the future. The implementation of automation should be human-centered, with due appreciation of the limitations and expectations of the pilots who are the end users of such automation. Author (revised)

A93-41321
TOWARD A FLIGHT DECK AUTOMATION PHILOSOPHY FOR THE BOEING HIGH SPEED CIVIL TRANSPORT
DAVID M. REGAL and ROLF J. BRAUNE (Boeing Commercial Airplane Group, Seattle, WA) Jul. 1992 9 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921133) Copyright

In this paper we address the role that automation will play in an advanced High Speed Civil Transport (HSCT) flight deck. It is argued that an automation philosophy is necessary to optimize design in the face of new technology that creates additional design options and adds to the complexity of the future flight deck design process. An overview of issues that influence the determination of an automation philosophy are presented along with specific items that will be part of that philosophy. We do not provide a comprehensive automation philosophy at this time, however. After a brief summary of Boeing's HSCT program, a detailed definition of automation, as it applies to the flight deck, is provided. A systems approach to flight deck design is described which is based on satisfying the aircraft's non-normal as well as normal mission requirements. Areas where pilots can make their strongest contributions as part of an overall flight deck system are identified, but it is suggested that the full potential of the crew can only be realized through the use of human-centered automation. Author

A93-41323* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
VISUALIZATION AND MODELING OF FACTORS INFLUENCING VISIBILITY IN COMPUTER-AIDED CREWSTATION DESIGN
ARIES ARDITI, STEVEN AZUETA (Lighthouse, Inc., New York), JAMES LARIMER (NASA, Ames Research Center, Moffett Field, CA), MICHAEL PREVOST (Sterling Software, Inc., Palo Alto, CA), JEFFREY LUBIN, and JAMES BERGEN (David Sarnoff Research Center, Princeton, NJ) Jul. 1992 12 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(Contract NCC2-541; NAS2-12852)
(SAE PAPER 921135) Copyright

We have developed two modules for use in computer-aided design (CAD) of crewstation environments that enhance the designer's appreciation of factors influencing the pilot's vision and visual processing capacity. The Binocular Optics Module (BOM) is an interactive tool for visualizing geometric aspects of (1) how retinal imagery of the environment changes on the pilot's retinas under conditions of eye and object motion, and (2) how visual capabilities that can be modeled as regions or contours on the retinas, affect spatial perception of the environment. The Visual Performance Module (VPM) contains a signal processing model of human visual discrimination that quantitatively predicts visual discrimination performance. The outputs of the VPM are retinal contours that represent performance probabilities. These contours may be used as inputs to the BOM for visualizing those volumes of space within the crewstation that bound different levels of the pilot's of visual discrimination capability. Used together, the BOM and VPM provide the designer with the opportunity to interactively explore relationships between environmental retinal imagery and visual function, and the ability to factor the pilot's visual capabilities into the earliest phases of crewstation CAD. Author

A93-41325* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SPACE STATION FREEDOM ENVIRONMENTAL HEALTH CARE PROGRAM
ELIZABETH E. RICHARD (Krug Life Sciences, Inc., Houston, TX) and DANE M. RUSSO (NASA, Johnson Space Center, Houston, TX) Jul. 1992 9 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921138) Copyright

The paper discusses the environmental planning and monitoring aspects of the Space Station Freedom (SSF) Environmental Health Care Program, which encompasses all phases of the SSF assembly and operation from the first element entry at MB-6 through the Permanent Manned Capability and beyond. Environmental planning involves the definition of acceptability limits and monitoring requirements for the radiation dose barothermal parameters and potential contaminants in the SSF air and water and on internal surfaces. Inflight monitoring will be implemented through the Environmental Health System, which consists of five subsystems: Microbiology, Toxicology, Water Quality, Radiation, and Barothermal Physiology. In addition to the environmental data interpretation and analysis conducted after each mission, the new data will be compared to archived data for statistical and long-term trend analysis and determination of risk exposures. Results of these analyses will be used to modify the acceptability limits and monitoring requirements for the future. AIAA

A93-41326
GLOVEBOX DESIGN FOR SPACE STATION FREEDOM CREW HEALTH CARE SYSTEM
FRANK T. EICHSTADT (McDonnell Douglas Space Systems, Space Station Div., Huntington Beach, CA) Jul. 1992 12 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992
(SAE PAPER 921139) Copyright

An account is given of the design status of the NASA-SSF Environmental Health System 'Glovebox', whose microbiology equipment encompasses incubators, a slide-stainer, and an Automated Microbiological Identification System. Attention is given to Glovebox volume relations to the user's functional and other human factors, ventilation system components, lighting conditions, and display and control locations. Maintainability has been a prominent consideration throughout, due to limited on-orbit resources. AIAA

A93-41327 National Aeronautics and Space Administration, Washington, DC.
PROGRAM DEVELOPMENT FOR EXERCISE COUNTERMEASURES
J. C. HAYES (Krug Life Sciences, Houston, TX), D. F. STEWART (NASA, Washington), B. A. HARRIS, S. F. SICONOLFI, M. C. GREENISEN, and F. T. LAROCHELLE (NASA, Johnson Space Center, Houston, TX) Jul. 1992 8 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921140) Copyright

The concern of NASA's Exercise Countermeasures Project (ECP) is to ensure crew physical effectiveness for flight- or mission-related tasks, and encompasses postflight as well as preflight and inflight exercise components. Attention is given to the implementation of ECP via the Space Shuttle Orbiter's treadmill, rower, cycle ergometer, and lower body negative pressure apparatus. AIAA

A93-41328
HYPERBARIC TREATMENT OPERATIONS ABOARD SPACE STATION FREEDOM
COURTNEY A. BUCK and MICHAEL F. STOLLE (McDonnell Douglas Space Systems, Space Station Div., Huntington Beach, CA) Jul. 1992 16 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921142) Copyright

Hyperbaric operations are required onboard Space Station Freedom to treat decompression sickness, air embolism, and ebullism and are essential to assure a continuing EVA capability. The Space Station Airlock provides the resources and equipment to accommodate hyperbaric operations, as well as a number of other operations including nominal EVA egress and ingress, prebreathing procedures, and space suit servicing. The Space Station Airlock has two chambers: the crewlock and the equipment lock. The crewlock is used as the hyperbaric chamber and can be pressurized to 41.1 psia for treatment. Both the crewlock and the equipment lock contain medical equipment and environmental control equipment to support hyperbaric operations. This paper discusses the role that both chambers play in efficiently accommodating the equipment in support of required hyperbaric procedures. In addition, a description of the medical hardware is offered, and the likely responsibilities and scenarios that include the two crew medical officers are detailed. Author (revised)

A93-41333
THE DEVELOPMENT OF AN ATMOSPHERE COMPOSITION MONITOR FOR THE ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM
WILLIAM NIU, MARY ROTHERAM, WALLY DENCKER, and LAARNI DAVIDSON (Perkin-Elmer Corp., Pomona, CA) Jul. 1992 12 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by Boeing Aerospace & Electronics refs
(SAE PAPER 921149) Copyright

The Atmosphere Composition Monitor (ACM), which is a part of the Environmental Control and Life Support System being developed for the Space Station Freedom, is described. The ACM will measure the major atmospheric constituents in the cabin to provide feedback for the nitrogen/oxygen replenishment control, as well particulates and minor gaseous constituents. The instruments of the ACM system include a single focusing mass spectrometer to monitor major air constituents; a gas chromatograph/mass spectrometer, to detect trace organic

contaminants resulting from material outgassing; a nondispersive IR spectrometer, to determine CO concentration; and a laser particle counter for measuring particulates in air. AIAA

A93-41335
OXYGEN GENERATION BY STATIC FEEDWATER ELECTROLYSIS FOR SPACE STATION FREEDOM
MICHAEL G. WOOD (Boeing Defense & Space Group, Huntsville, AL) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by Life Systems, Inc refs
(SAE PAPER 921151) Copyright

The paper describes the Static Feed Water Electrolysis System (SFWES), designed for the ECLSS as part of the Atmosphere Revitalization Subsystem, with particular attention given to the technology and operation of the SFWES. The SFWES will generate oxygen and hydrogen aboard the Space Station Freedom from water obtained from the potable water processor. Oxygen will be produced at a level sufficient to support astronaut metabolic consumption, animal metabolic consumption, experiment ingestion, cabin leakage, and airlock loss. The hydrogen byproduct will enter the Carbon Dioxide Reduction Subassembly where the hydrogen will react with concentrated CO2 to form recyclable water and waste methane. Results of testing to date are presented, and the viability of the SFWES as the oxygen generator for SSF is discussed. AIAA

A93-41337* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
A COMPARISON OF TWO SHUTTLE LAUNCH AND ENTRY SUITS - REACH ENVELOPE, ISOKINETIC STRENGTH, AND TREADMILL TESTS
LAUREN E. SCHAFER, SUDHAKAR L. RAJULU (Lockheed Engineering & Sciences Co., Houston, TX), and GLENN K. KLUTE (NASA, Johnson Space Center, Houston, TX) Jul. 1992 7 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992
(SAE PAPER 921154) Copyright

A quantification has been conducted of any existing differences between the performance, in operational conditions, of the Space Shuttle crew Launch Entry Suit (LES) and the new Advanced Crew Escape Suit (ACES). While LES is a partial-pressure suit, the ACES system which is being considered as a replacement for LES is a full-pressure suit. Three tests have been conducted with six subjects to ascertain the suits' reach envelope, strength, and treadmill performance. No significant operational differences were found between the two suit designs. AIAA

A93-41338* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PILOT INVESTIGATION - NOMINAL CREW INDUCED FORCES IN ZERO-G
GLENN K. KLUTE (NASA, Johnson Space Center, Houston, TX) Jul. 1992 8 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921155) Copyright

This report presents pilot-study data of test subject forces induced by intravehicular activities such as push-offs and landings with both hands and feet. Five subjects participated in this investigation. Three orthogonal force axes were measured in the NASA KC-135 research aircraft's 'zero-g' environment. The largest forces were induced during vertical foot push-offs, including one of 534 newtons (120 lbs). The mean vertical foot push-off was 311 newtons (70 lbs). The vertical hand push-off forces were also relatively large, including one of 267 newtons (60 lbs) with a mean of 151 newtons (34 lbs). These force magnitudes of these forces would result in a Shuttle gravity environment of about 1 x exp 10 -4 g's. Author (revised)

A93-41339* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
OPERATIONAL SPACE HUMAN FACTORS - METHODOLOGY FOR A DSO
THOMAS F. CALLAGHAN, JOHN W. GOSBEE (Lockheed Engineering & Sciences Co., Houston, TX), and SUSAN C. ADAM (NASA, Johnson Space Center, Houston, TX) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921156) Copyright

The Human Factors Assessment of Orbiter Missions (Detailed Supplementary Objective 904) was conducted on STS-40 (Spacelab Life Sciences 1) in order to bring human factors into the operational world of manned space flight. This paper describes some of its methods. Included are explanations of general and space human factors, and a description of DSO 904 study objectives and results. The methods described include ways to collect background information for studies and also different in-flight data collection techniques. Several lessons for the space human factors engineer are reflected in this paper. First, method development is just as important as standards generation. Second, results of investigations should always have applicability to design. Third, cooperation with other NASA groups is essential. Finally, the human is the most important component of the space exploration system, and often the most difficult to study. Author

A93-41340* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
A STUDY TO EXPLORE LOCOMOTION PATTERNS IN PARTIAL GRAVITY ENVIRONMENTS
SUDHAKAR L. RAJULU (Lockheed Engineering & Sciences Co., Houston, TX), GLENN K. KLUTE, and NATHAN R. MOORE (NASA, Johnson Space Center, Houston, TX) Jul. 1992 12 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921157) Copyright

An effort is made to ascertain the factors affecting stability during locomotion in lunar and Martian gravity environments, as well as to establish criteria for the enhancement of stability and traction. The effects of changing both the speed and the pattern of locomotion under three different gravity conditions were investigated. As gravity level increased, vertical and horizontal forces significantly declined; similarities were noted across gravity levels, however, with respect to locomotion speed and pattern changes, where increasing speed enhanced both vertical and horizontal forces. With decreasing gravity, the ratio of horizontal to vertical forces increased significantly. AIAA

A93-41341* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE CENTRIFUGE FACILITY LIFE SCIENCES GLOVEBOX CONFIGURATION STUDY
SIDNEY C. SUN (NASA, Ames Research Center, Moffett Field, CA) and CARLA V. GOULART (Colorado Univ., Boulder) Jul. 1992 13 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921158) Copyright

Crew operations associated with nonhuman life sciences research on Space Station Freedom will be conducted in the Life Sciences Glovebox, whose enclosed work volume must accommodate numerous life science procedures. Two candidate Glovebox work volume concepts have been developed: one in which two operators work side-by-side, and another that conforms to the reach envelope of a single operator. Six test volunteers tested the concepts according to preestablished operational criteria. The wrap-around, single-operator concept has been judged the superior system. AIAA

A93-41342
ZERO GRAVITY PHASE SEPARATOR TECHNOLOGIES - PAST, PRESENT AND FUTURE
W. C. DEAN (Hamilton Standard, Windsor Locks, CT) Jul. 1992 9 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992
(SAE PAPER 921160) Copyright

Accounts are given of the development history, current status and prospective trends in the design of systems for removing

condensate from temperature/humidity control heat exchangers in zero gravity. Attention is given to such major configurational possibilities as the integral-wick and face-wick separators, the hydrophylic-coated hollow-chamber 'slurper', the elbow wick, and the hydrophylic gas trap. AIAA

A93-41343* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
DESIGN OF A SHUTTLE AIR AND WATER PREFILTER FOR REDUCED GRAVITY OPERATION
EUGENE K. UNGAR and FRED A. OUELLETTE (NASA, Johnson Space Center, Houston, TX) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921161) Copyright

The first design concept of the Space Shuttle humidity separator prefilter, developed to remove debris from the air/water stream which flows from the cabin condensing heat exchanger to the humidity separator, was flown on STS-40 in June 1991. This paper discusses the design of the first prefilter (which was found not to pass water at a constant rate, resulting in a tendency to slug the humidity separator) and explains the on-orbit performance of the prefilter. The redesigned prefilter (made using the results of the flight test of the first prefilter) is described, with particular attention given to the features which would allow successful reduced gravity operation. AIAA

A93-41344
DEVELOPMENT OF MEMBRANE GAS REMOVAL TECHNOLOGY FOR MICROGRAVITY LIQUID FLOW SYSTEMS
ROBERT C. DALEE (McDonnell Douglas Space Systems, Huntsville, AL), JERE POTEAT, and MONTY HEYING (McDonnell Douglas Missile Systems Co., Saint Louis, MO) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921162) Copyright

The possible problems associated with gas accumulation during long-term microgravity missions are discussed along with the expected sources of the gases, both free and dissolved. The membrane gas-removal technology considered for alleviating these problems is examined, with particular attention given to two small, light-weight hardware prototype Shell-N-Tube degassers which currently undergo development testing with promising results. Other methods for gas removal are examined, including the use of hydrophilic screen retention devices. AIAA

A93-41345
TWO PHASE FLUID MANAGEMENT FOR HYDROPONICS
ROBERT L. CURTIS (Curtis Aerospace, Inc., Fort Worth, TX) Jul. 1992 7 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921163) Copyright

In order to make hydroponics a practical solution in the microgravity conditions, it is necessary to have a technique for effectively separating air from water in a simple manner, since air bubbles in the water supply system could lead to catastrophic failure of the hydroponic system. This paper presents several concepts of an efficient liquid/gas separator (LGS), with particular attention given to the design, development test, and operation of a LGS in a hydroponic system for microgravity application. AIAA

A93-41346* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
CONCEPTUAL DESIGN OF ECLSS MICROGRAVITY TEST BEDS
MATT KOLODNEY (Lockheed Engineering & Sciences Co., Houston, TX) and LIESE DALL-BAUMAN (NASA, Johnson Space Center, Houston, TX) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921164) Copyright

Conceptual designs were prepared for Space Station Freedom ECLSS test beds for both the Air Revitalization Subsystem (ARS) and the Water Recovery and Management Subsystem (WRMS), which will allow extended testing of equipment under microgravity conditions. The separate designs for the ARS and the WRMS include storage tanks, plumbing, and limited instrumentation that would be expected to be common to all air or water treatment equipment of interest. The beds are designed to recycle process fluids to the greatest extent possible, thus minimizing the spacecraft/test bed interface requirements. Schematic diagrams of both the ARS and the WRMS test beds are included. AIAA

A93-41365* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
INITIAL ACCOMPLISHMENTS OF THE ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM (ECLSS) ATMOSPHERE REVITALIZATION (AR) PREDEVELOPMENT OPERATIONAL SYSTEM TEST (POST) FOR THE SPACE STATION FREEDOM (SSF)
KEVIN H. DUNN and PETER J. BULGAJEWSKI (Boeing Defense & Space Group, Huntsville, AL) Jul. 1992 14 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(Contract NAS8-50000)
(SAE PAPER 921186) Copyright

Initial results of the integrated AR POST conducted by Boeing at Marshall Space Flight Center in 1992 are presented. The three baselined ECLSS Man Tended Capability AR assemblies were integrated and operated in a closed door chamber in which the internal atmosphere was monitored. The test provides a prerequisite checkout of the AR subsystem in preparation for longer duration tests in which the AR subsystem will be integrated with the Water Recovery Management subsystem. The integrated AR POST will serve as an early test bed to evaluate the integration of the space station ECLSS AR subsystem during design maturation. AIAA

A93-41367
DEVELOPMENT OF THE CARBON DIOXIDE REMOVAL SYSTEM BLOWER USED ON SPACE STATION FREEDOM
BERNARD HAFELE (Allied-Signal Aerospace, Torrance, CA) Jul. 1992 9 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by Boeing Aerospace and Electronics Co
(SAE PAPER 921188) Copyright

The design and development of a blower for the carbon dioxide removal assembly (CDRA) system are described. A mixed-flow blower was selected as the optimum design to meet the CDRA application requirements due to its low weight, small size, and outstanding efficiency. The blower unit is equipped with air bearings for extremely long life. AIAA

A93-41368
SABATIER CARBON DIOXIDE REDUCTION SYSTEM FOR SPACE STATION FREEDOM
ROBERT B. BOYDA, M. G. LEE, and DAVID J. GRIGGER (Life Systems, Inc., Cleveland, OH) Jul. 1992 8 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992
(SAE PAPER 921189) Copyright

Regenerative processes for the revitalization of spacecraft atmospheres are required for extended duration space missions like the Space Station Freedom. A major atmosphere revitalization function is the recovery of oxygen from metabolic carbon dioxide by means of carbon dioxide reduction. The Sabatier carbon dioxide reduction technology is the baseline technology for the Space Station Freedom for this purpose. Life Systems has performed characterization and endurance testing of Sabatier reactor assemblies that has been used to design a prototype Sabatier reactor that complies with the performance requirements of the Space Station Freedom Carbon Dioxide Reduction Assembly. Information presented in the paper defines the testing that was used to design the prototype reactor and presents the successful test results that have been achieved using this reactor as part of an automated Sabatier-based Carbon Reduction Assembly. Reactor

performance as a function of temperature, pressure, and reactant stoichiometry is defined. Author (revised)

A93-41371
LABELS AND VISUAL CUES TO REPRODUCE AN EARTHLIKE ENVIRONMENT IN SPACE - GOING AHEAD IN DESIGNING COLUMBUS APM INTERIOR ARCHITECTURE
FABIANA BOBBA, GIORGIO MUSSO, and MARCO BARIN (Alenia Spazio S.p.A., Turin, Italy) Jul. 1992 9 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921193) Copyright

Labels and cues for the Columbus Attached Pressurized Module (APM) are analyzed in the context of the human factors. Different methods for supporting crew orientation are proposed for test in the Columbus APM habitability mock-up, where color selection has been already implemented. General level suggestions on the APM labelling system are presented, which include stress color coding of large elements and equipment, introduction of clear indications of escape routes (hatches), identification of hatches and their mode of aperture, continuous identification of up and down, right and left, and the use of areas with different brightness level. AIAA

A93-41373
CROP INTERACTIONS IN POLYCULTURE AND THEIR IMPLICATIONS FOR CELSS DESIGN
T. STROUP and S. SCHWARTZKOPF (Lockheed Missiles & Space Co., Inc., Sunnyvale, CA) Jul. 1992 6 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921197) Copyright

A Controlled Ecological Life Support System (CELSS) in which crop plants would be grown to produce food during long duration space missions is described. Lettuce and tomato plants were grown in a shared, recirculation nutrient solution to examine the effects of mutual interaction. Results show that growth of the first crop of lettuce was unaffected or even slightly enhanced by growing it in polyculture with tomato plants. These experiments revealed that there are significant plant-plant interactions in hydroponic nutrient solutions. AIAA

A93-41374
A TRADE STUDY METHOD FOR DETERMINING THE DESIGN PARAMETER OF CELSS SUBSYSTEMS
KOZO SATO (Inst. for Future Technology, Tokyo, Japan), HIDEAKI HAMAMI (Chiyoda Corp., Japan), AKIRA ASHIDA (Hitachi, Ltd., Yokohama, Japan), MIKIO SATO (Toyo Engineering Corp., Japan), YOSHINORI MIDORIKAWA (JGC Corp., Tokyo, Japan), and KEIJI NITTA (National Aerospace Lab., Chofu, Japan) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921198) Copyright

A trade study method for determining the subsystem design parameters of Controlled Ecological Life Support System (CELSS) is presented. The trade study method is based on the break down of the system configuration into material flow levels between the total closed loop life support facility and the outside environment; between the plantation, habitat, and animal breeding modules; between each subsysten in each module; and in each subsystem. AIAA

A93-41375* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
AN APPROACH TO THE FUNCTIONAL OPTIMIZATION OF THE CELSS TEST FACILITY
BORIS S. YENDLER (NASA, Ames Research Center, Moffett Field, CA) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by National Research Council refs
(SAE PAPER 921199) Copyright

An optimization of the CELSS Test Facility (CTF) subsystems and the entire CTF is necessary in order to meet strict limitations imposed on mass, volume, and power. Depending on the subsystem, other requirements must also be met. This paper shows the way to examine compatibility of requirements, to define an area of existing solutions (an operational envelope), and to find an optimal solution. The workability of the method is shown using problems of heat load on the Plant Growth Chamber, of optimization of the Vapor-Air Membrane Separation Device, and of finding a CTF configuration with minimum air pressure drop. Author

A93-41376
EUROPEAN INVOLVEMENT IN CELSS - DEFINITION OF A CLOSED ECOLOGICAL SYSTEMS TEST BED
C. TAMPONNET (ESTEC, Noordwijk, Netherlands), M. COLASSON (Interval, Paris, France), and M. PASTOR (Nuevas Tecnologias Espaciales, S.A., Lissa d'Amunt, Spain) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921200) Copyright

This work was to provide the ESA with technical and architectural guidelines for the eventual building of a Closed Ecological System Test Bed. This work had three successive targets. The first target has been the definition of the general objectives and the specific requirements for a closed ecological system test bed. It shall have the appropriate flexibility which will enable the users to perform separately and/or in parallel, multiple tasks. Indeed, some biological life support units may also be investigated as specific support to the currently on-going European manned space projects. In addition, some concepts for the test bed have been defined taking into account the rather contractory needs for a sealed structure and for structural and functional flexibility. One of them has been the subject of a preliminary architectural definition which is presented with some detail. Finally, the important terrestrial applications of such a CES test bed have been considered. Author

A93-41377
FUNCTIONS SIMULATION MODEL OF INTEGRATED REGENERABLE LIFE SUPPORT SYSTEM
EHDUARD A. KURMAZENKO, ALEKSANDR A. FOMICHEV (International Center for Advanced Studies COSMOS, Russia), and IVAN V. DOKUNIN (NII Khimicheskogo Mashinostroeniya, Moscow, Russia) Jul. 1992 15 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921201) Copyright

Attention is given to the functions simulation model (FSM) of the manned space orbital station integrated life support system (IRLSS) designed to investigate IRLSS temporary responses. It is argued that the FSM which can be used for functional analysis must be reflected in the structure of the orbital station's ecological-technical system, including the formalistic functional descriptions of the IRLSS subsystems and the environment links. AIAA

A93-41386* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
A SYSTEMS APPROACH TO WATER RECOVERY TESTING FOR SPACE LIFE SUPPORT - INITIAL BIOMEDICAL RESULTS FROM THE ECLSS WATER RECOVERY TEST AND PLANS FOR TESTBED UTILIZATION
LAURIE A. ATEN, WILLIAM J. CRUMP (Alabama Univ., Huntsville), and RICHARD L. SAUER (NASA, Johnson Space Center, Houston, TX) Jul. 1992 17 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921210) Copyright

Among the challenges of designing and constructing Space Station Freedom is the development of the water system. A review of past efforts in reclaiming waste water in enclosed environments reveals that there are many gaps in the biomedical understanding of this process. Some of the key uncertainties of human interaction with a closed water system include determining potential contaminants and establishing safe levels of multiple compounds

in the enclosed system of Space Station. Another uncertainty is the microbial constituency of such a system and what impact it could have on crew health and performance. The use of iodine as the passive biocide may have both an indirect and direct impact on the crew. In this paper the initial results of the Water Recovery Test are reviewed from a biomedical perspective, revealing areas where more information is needed to develop the ECLSS water system. By including the approach of 'man as a subsystem', consideration is given to how man interacts with the total water system. Taking this systems approach to providing the crew with a safe source of water gives useful insight into the most efficient design and utilization of closed system testbeds. Author

A93-41387* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
AQUATIC BIOFILMS AND THEIR RESPONSES TO DISINFECTION AND INVADING SPECIES
G. A. SMITHERS, E. B. RODGERS (NASA, Marshall Space Flight Center, Huntsville, AL), D. C. OBENHUBER, and T. L. HUFF (Sverdrup Technology, Inc., Huntsville, AL) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921211) Copyright

The control of microbial contamination is a primary concern in the development of a water reclamation system for long-duration manned space flights. This paper describes bench-scale experiments, using both static and recycling water systems, investigating the interaction of bacterial species in the development of a biofilm and their response to the introduction of a disinfectant or of additional species. The results showed that iodine concentrations as high as 15 to 20 mg/l I2 are necessary to completely disinfect a stable biofilm. When S. aueus and E. coli were introduced into a system containing natural mixed culture biofilms, their colonization in the biofilms increased their survival time, from 3 to 5 days as unattached cells to over 60 days when protected in the biofilms. While iodine concentrations of 0.5 to 1 mg/l were enough to eliminate these organisms from the bulk water, concentrations higher than 4.0 mg/l were necessary to completely eliminate these organisms from the biofilm. AIAA

A93-41389* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
MICROBIOLOGY OPERATIONS AND FACILITIES ABOARD RESTRUCTURED SPACE STATION FREEDOM
LOUIS A. CIOLETTI, S. K. MISHRA (Krug Life Sciences, Inc., Houston, TX), and DUANE L. PIERSON (NASA, Johnson Space Center, Houston, TX) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921213) Copyright

With the restructure and funding changes for Space Station Freedom, the Environmental Health System (EHS)/Microbiology Subsystem revised its scheduling and operational requirements for component hardware. The function of the Microbiology Subsystem is to monitor the environmental quality of air, water, and internal surfaces and, in part, crew health on board Space Station. Its critical role shall be the identification of microbial contaminants in the environment that may cause system degradation, produce unsanitary or pathogenic conditions, or reduce crew and mission effectiveness. EHS/Microbiology operations and equipment shall be introduced in concert with a phased assembly sequence, from Man Tended Capability (MTC) through Permanently Manned Capability (PMC). Effective Microbiology operations and subsystem components will assure a safe, habitable, and useful spacecraft environment for life sciences research and long-term manned exploration. Author

A93-41392
PRESSURE, COMPOSITION, AND TEMPERATURE CONTROL OF CABIN ATMOSPHERE ON SPACE STATION FREEDOM
KEVIN C. MOORE, JOHN KNOX, and CRAIG STANTON (Boeing Defense & Space Group, Missiles & Space Div., Huntsville, AL) Jul. 1992 16 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921216) Copyright

A dynamic model of the cabin atmosphere onboard Space Station Freedom is presented. Hardware to regulate the pressure and temperature is modeled. Control laws that provide regulation of cabin pressure. Oxygen partial pressure, and temperature are presented. The performance of the proposed controller design concept is evaluated. Author

A93-41401
DEW POINT ANALYSIS FOR SPACE STATION FREEDOM
ROGER G. VON JOUANNE, ROBERT S. BARKER, and GLENN A. SITLER (Boeing Defense & Space Group, Missiles & Space Div., Huntsville, AL) Jul. 1992 16 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921227) Copyright

G189A Environmental Control and Life Support System (ECLSS) dew point models for Space Station Freedom (SSF) are reviewed. The modeling of the cabin air heat exchangers, metabolic modeling of crew members, the application of latent loads, and the operation of the CO2 removal assembly are examined. Some significant computed results from these models are reviewed which show transient dew point responses during maximum and minimum dew point conditions on board SSF. AIAA

A93-41402
COMPARATIVE TEST DATA ASSESSMENT AND SIMPLIFIED MATH MODELLING FOR SABATIER CO2 REDUCTION SUBSYSTEM
CHANG H. SON and ROBERT S. BARKER (Boeing Defense & Space Group, Missiles & Space Div., Huntsville, AL) Jul. 1992 13 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921228) Copyright

An assessment of the test data obtained from the Comparative Test of the Sabatier CO2 Reduction Subsystem of the Environmental Control and Life Support System on Space Station Freedom is reported. The assessment was achieved through correlation of measured data for outlet gas constituent flow rates and reactor front end temperatures with corresponding computed data from a simplified mathematical model. The computed data from the model correlates with the test data for bed temperature within 3 percent and gas composition data within 21 percent. AIAA

A93-41404
SIMPLIFIED ANALYSIS OF WATER DISTRIBUTION FOR SPACE STATION FREEDOM
EDSON A. WORDEN (Boeing Defense & Space Group, Huntsville, AL) Jul. 1992 13 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921230) Copyright

Space Station Freedom (SSF) is required to distribute water for use and reprocessing. As SSF is erected, the configuration of the water distribution system changes along with specific functions. Therefore the interaction of the various components changes radically. Also, these components are taken off-line intermittently for maintenance (such as filter replacement). In order to analyze these interactions, a simplified steady state computer model was prepared. Parameters such as set points and storage tank capacities were revised based upon new performance understanding. The model was built using a Lotus 1-2-3 program. The model, making extensive use of macros, was iterated over thousands of hours of simulated SSF water processing in orbit. The data was stored and plotted. With the aid of the results of this modeling, the flight design was refined to a high level of maturity. Author

A93-41405* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
EVALUATION OF THE CARBON DIOXIDE REMOVAL ASSEMBLY REQUIREMENTS FOR THE SPACE STATION FREEDOM IN THE MANNED TENDED CAPABILITY THROUGH PERMANENTLY MANNED CAPABILITY CONFIGURATIONS
J. C. KNOX (NASA, Marshall Space Flight Center, Huntsville, AL) and S. D. GILLEY (Sverdrup Technology, Inc.; NASA, Marshall Space Flight Center, Huntsville, AL) Jul. 1992 22 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921231) . Copyright

Analyses have been conducted to assess the capability of the Atmosphere Revitalization Subsystem to control ambient CO2 levels of the Space Station Freedom (SSF). The adequacy of the Carbon Dioxide Removal Assembly (CDRA) performance to meet design requirements has been evaluated. Analyses considered transient effects of crew location and metabolic loading on SSF Restructure configurations. The analyses consisted of computer simulations of on-orbit conditions using both supplier-provided and adjusted CO2 removal performance approximations along with derived crew metabolic activities and locations. Results show that while the current performance of the CDRA will maintain CO2 levels within specifications for Man-Tended Operations, it cannot maintain the SSF atmosphere below specifications during Permanently Manned Operations. Potential design options are discussed and other relevant analyses are summarized.
Author (revised)

A93-41406* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
MICROBIOLOGICAL CONCERNS AND METHODOLOGICAL APPROACHES RELATED TO BACTERIAL WATER QUALITY IN SPACEFLIGHT
BARRY H. PYLE and GORDON A. MCFETERS (Montana State Univ., Bozeman) Jul. 1992 7 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(Contract NAG9-241; NAG9-505)
(SAE PAPER 921232) Copyright

A number of microbiological issues are of critical importance to crew health and system performance in spacecraft water systems. This presentation reviews an army of these concerns which include factors that influence water treatment and disinfection in spaceflight such as biofilm formation and the physiological responses of bacteria in clean water systems. Factors associated with spaceflight like aerosol formation under conditions of microgravity are also discussed within the context of airborne infections such as Legionellosis. Finally, a spectrum of analytical approaches is reviewed to provide an evaluation of methodological alternatives that have been suggested or used to detect microorganisms of interest in water systems. These range from classical approaches employing colony formation on specific microbiological growth media to direct (i.e. microscopic) and indirect (e.g. electrochemical) methods as well as the use of molecular approaches and gene probes. These techniques are critically evaluated for their potential utility in determining microbiological water quality through the detection of microorganisms under the influence of ambient environmental stress inherent in spaceflight water systems.
Author (revised)

A93-41407
INSTRUMENTATION FOR MICROBIAL MONITORING OF DECONTAMINATION OR BIOCIDE SYSTEM EFFECTIVENESS
GORDON SNYDER (Gordon Snyder & Consultants, Inc., Seattle, WA) and JARROD D. O'LEARY (Perkin-Elmer Corp., Pomona, CA) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921233) Copyright

A Viable Microbial Monitor (VMM) for detection and enumeration of viable microorganisms is presented. The VMM, an instrument system for the rapid detection of bacterial or fungal contamination, is based on conductance microbiology which depends on the well established ability of microorganisms to change conductance of their growth media. It is concluded that this innovative technology has potential for space applications because individual and multiple sensors can be integrated into a time saving system that accommodates microgravity conditions and produced real-time microbial growth data using computer controlled automation.
AIAA

A93-41408
WATER PURIFICATION, MICROBIOLOGICAL CONTROL, STERILIZATION AND ORGANIC WASTE DECOMPOSITION USING AN ELECTROCHEMICAL ADVANCED OZONATION PROCESS
TOM D. ROGERS, G. D. HITCHENS, CARLOS E. SALINAS, OLIVER G. MURPHY (Lynntech, Inc., Bryan, TX), and HOWARD W. WHITFORD (Texas Veterinary Medical Diagnostic Lab., TX) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by Small Business Innovation Research Program refs
(Contract DAMD17-91-C-1105)
(SAE PAPER 921234) Copyright

Electrochemical oxidant generation has been combined with UV photolysis to provide a highly effective means of water purification, decomposition of bacterial organic substances, microbiological control and sterilization. Ozone is an oxidant with many unique features that make it a valuable tool for biomedical applications. It is an excellent bactericidal, virucidal and sporicidal agent making it ideal for use as a sterilant. Combining O3 with UV radiation stimulates formation of hydroxyl radicals (OH) which accelerates a wide range of organic oxidations. While in some instances maintenance of an oxidant residual is necessary, the residual can be rapidly removed by UV light at the point of use (i.e., Water For Injection). Test results on pyrogen decomposition, bacterial organic decomposition, microbiological sterilization, residual removal and water purification as a final step for producing pharmaceutical grade water are discussed.
Author

A93-41411
DEVELOPMENT OF THE NITROGEN FIXATION SYSTEM FOR CELSS
M. INOUE, S. IIYAMA, T. NUMAGUCHI, K. KIKUCHI (Toyo Engineering Corp., Japan), and K. NITTA (National Aerospace Lab., Chofu, Japan) Jul. 1992 8 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921238) Copyright

The practical nitrogen fixation system configuration for CELSS is described. The nitrogen fixation system encompasses subsystems for low pressure ammonia synthesis based on Ru catalyst, ammonia separation, and nitric acid synthesis with Pt-Rh catalyst. Results of the ammonia synthesis tests conducted at 0-1.0 MPa and 573-673 K are presented. Data obtained demonstrates the feasibility of the proposed nitrogen fixation process for CELSS.
AIAA

A93-41412
CONCEPT OF WASTE TRANSFERRING MECHANISMS
ATSUSHI SHIRAISHI (Fujitsu, Ltd., Tokyo, Japan) and KEIJI NITTA (National Aerospace Lab., Chofu, Japan) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921239) Copyright

Recycling human and animal excreta is an important part of the proposed Closed Ecology Experiment Facility (CEEF) in Japan. This paper introduces a conceptual design for the waste collection and transfer system. Mineral-rich wastes such as urine and wool grease must be separated from other wastes to recover the minerals. Solids and liquids also require separate handling methods. Our design uses inclined conveyer belts to separate feces and urine. A fluorocarbon polymer coating prevents wastes from sticking to the belt. In-line freezers are used to solidify liquid wastes and retard premature decomposition. A summary of available data on

animal excreta is included, but there is a distinct shortage of useful information. This data is insignificant for usual biology or animal husbandry, but is essential for designing the self-contained environment. Author

A93-41413* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
OCAM - A CELSS MODELING TOOL: DESCRIPTION AND RESULTS
ALAN DRYSDALE, MARK THOMAS, MARK FRESA (McDonnell Douglas Space Systems Co., Cocoa Beach, FL), and RAY WHEELER (NASA, Kennedy Space Center, Cocoa Beach, FL) Jul. 1992 12 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921241) Copyright

Controlled Ecological Life Support System (CELSS) technology is critical to the Space Exploration Initiative. NASA's Kennedy Space Center has been performing CELSS research for several years, developing data related to CELSS design. We have developed OCAM (Object-oriented CELSS Analysis and Modeling), a CELSS modeling tool, and have used this tool to evaluate CELSS concepts, using this data. In using OCAM, a CELSS is broken down into components, and each component is modeled as a combination of containers, converters, and gates which store, process, and exchange carbon, hydrogen, and oxygen on a daily basis. Multiple crops and plant types can be simulated. Resource recovery options modeled include combustion, leaching, enzyme treatment, aerobic or anaerobic digestion, and mushroom and fish growth. Results include printouts and time-history graphs of total system mass, biomass, carbon dioxide, and oxygen quantities; energy consumption; and manpower requirements. The contributions of mass, energy, and manpower to system cost have been analyzed to compare configurations and determine appropriate research directions. Author (revised)

A93-41418
THE EFFECTS OF A REDUCED PRESSURE SCENARIO ON THE COLUMBUS APM ENVIRONMENTAL CONTROL SYSTEM
EUGENIO GARGIOLI and CESARE LOBASCIO (Alenia Spazio S.p.A., Turin, Italy) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921247) Copyright

The results are reported of a study to identify the contraints and problems in the Columbus APM operations at reduced pressure. The effects of reduced pressure on the Environmental Control System are considered as regards avionics air cooling, ventilation requirements and crew comfort, and subfloor cooling. The impact on components and materials is addressed, including heat exchanger performances, humidity removal, fan performance, flammability, and the selection of materials. AIAA

A93-41419* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SPACE STATION FREEDOM FOOD MANAGEMENT
TROY N. WHITEHURST, JR. (Boeing Defense & Space Group, Seattle, WA) and CHARLES T. BOURLAND (NASA, Johnson Space Center, Houston, TX) Jul. 1992 7 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921248) Copyright

This paper summarizes the specification requirements for the Space Station Food System, and describes the system that is being designed and developed to meet those requirements. Space Station Freedom will provide a mix of frozen, refrigerated, rehydratable, and shelf stable foods. The crew will pre-select preferred foods from an approved list, to the extent that proper nutrition balance is maintained. A galley with freezers, refrigerators, trash compactor, and combination microwave and convection ovens will improve crew efficiency and productivity during the long Space Station Freedom (SSF) missions. Author

A93-41420
CREW HEALTH CARE SYSTEMS INSTALLATIONS FOR SPACE STATION FREEDOM
PETE GADSBY, FRANK EICHSTADT, and ED CORDES (McDonnell Douglas Space Systems, Space Station Div., Huntington Beach, CA) Jul. 1992 9 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992
(SAE PAPER 921249) Copyright

This paper presents an overview of the design and development of Crew Health Care Systems (CHeCS) for Space Station Freedom with an emphasis on physical installation and flight crew suitability. Particular emphasis is directed at unique aspects of the system which are driven by environmental peculiarities such as limited volume and resources (electrical power, heat rejection, crew time, launch constraints), location remoteness, isolation, and microgravity, while minimizing detriment to other nonrelated Space Station operations. Design implications resulting from phased Space Station build-up are also described. General and specific topics involve selected component and installations designs, development testing and simulation activities, and system design integration into Space Station elements. Implications introduced by CHeCS relationships to the Space Transportation System are also presented. Author (revised)

A93-41423* National Aeronautics and Space Administration, Washington, DC.
A FEASIBILITY STUDY OF HAND KINEMATICS FOR EVA ANALYSIS USING MAGNETIC RESONANCE IMAGING
REUBEN D. DICKENSON (Vanderbilt Univ., Nashville, TN), CHRISTINE H. LORENZ (Vanderbilt Medical Center, Nashville, TN), STEVEN W. PETERSON, ALVIN M. STRAUSS, and JOHN A. MAIN (Vanderbilt Univ., Nashville, TN) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by NASA refs
(SAE PAPER 921253) Copyright

A new method for analyzing the kinematics of joint motion using magnetic resonance imaging (MRI) is described. The reconstruction of the metacarpalphalangeal joint of the left index finger into a 3D graphic display is shown. From the reconstructed volumetric images, measurements of the angles of movement of the applicable bones are obtained and processed by analyzing the screw motion of the joint. Landmark positions are chosen at distinctive locations of the joint at fixed image threshold intensity levels to ensure repeatability. The primarily 2D planar motion of this joint is then studied using a method of constructing coordinate systems using three or more points. A transformation matrix based on a world coordinate system describes the location and orientation of the local target coordinate system. The findings show the applicability of MRI to joint kinematics for gaining further knowledge of the hand-glove design for EVA. AIAA

A93-41424* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
DEVELOPMENT OF A TEST PROTOCOL FOR EVALUATING EVA GLOVE PERFORMANCE
ELAINE M. HINMAN (NASA, Marshall Space Flight Center, Huntsville, AL) Jul. 1992 20 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921254) Copyright

Testing gloved hand performance involves work from several disciplines. Evaluations performed in the course of reenabling a disabled hand, designing a robotic end effector or master controller, or hard-suit design have all yielded relevant information, and, in most cases, produced performance test methods. Most times, these test methods have been primarily oriented toward their parent discipline. For space operations, a comparative test which would provide a way to quantify pressure glove and end effector performance would be useful in dividing tasks between humans and robots. Such a test would have to rely heavily on sensored measurement, as opposed to questionnaires, to produce relevant data. However, at some point human preference would have to

be taken into account. This paper presents a methodology for evaluating gloved hand performance which attempts to respond to these issues. Glove testing of a prototype glove design using this method is described. Author (revised)

A93-41425* National Aeronautics and Space Administration, Washington, DC.
POWER ASSIST EVA GLOVE DEVELOPMENT
JOHN A. MAIN, STEVEN W. PETERSON, and ALVIN M. STRAUSS (Vanderbilt Univ., Nashville, TN) Jul. 1992 17 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by NASA refs
(SAE PAPER 921255) Copyright

The design of the EVA glove is examined, emphasizing the development of a more flexible metacarpophalangeal (MCP) joint for the EVA glove. The analysis of the EVA glove MCP joint is reviewed and the glove design process is recapitulated. Experimental tests of the glove are summarized. AIAA

A93-41426
DEVELOPMENT OF THE HERMES EVA SPACE SUIT GLOVE
DAVID A. NICE (Aerazur, Issy-les-Moulineaux, France), JEAN-LOUIS THONNARD, and LEON PLAGHKI (Louvain, Univ. Catholique, Louvain-la-Neuve, Belgium) Jul. 1992 23 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by ESA and Dassault Aviation refs
(SAE PAPER 921256) Copyright

The development phase of the Hermes EVA (Extra Vehicular Activity) Space Suit Glove began with a review of EVA Glove literature and a parallel study of hand biomechanics. The glove had three principal layers; Bladder, Restraint and Thermal Micrometeoroid Protection, (TMP). Range of motion, strength, tactile perception, dexterity, fatigue and comfort were assessed through the test program. The testing revealed a decrease in performance. Thermal contact testing was performed with the glove interfaced to a U.S. Shuttle EMU (Extravehicular Mobility Unit). Further evaluation was performed with the glove interfaced to a Soviet Orlan DMA suit. The testing identified a number of glove improvements. Author

A93-41427
DEVELOPMENT OF A 500 HPA SHOULDER JOINT FOR THE EUROPEAN EVA SPACE SUIT SYSTEM
Y. OLLIVIER, X. LABOURDETTE (Dassault Aviation, St.-Cloud, France), M. DIENER (Dornier GmbH, Friedrichshafen, Germany), and V. MENENDEZ (Zodiac Espanola, S.A., Figueras, Spain) Jul. 1992 13 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by ESA refs
(SAE PAPER 921257) Copyright

This paper synthesizes the shoulder joint development activities performed in the framework of the European EVA Space Suit System program. The shoulder joint belongs to the anthropomorphic enclosure encompassing the crewmember, protecting him against the space environment while ensuring him adequate mobility, dexterity, and visibility. A conceptual trade-off selected two candidates likely to fulfill the stringent shoulder joint requirements: an all-soft joint and a hybrid 'rolling convolute'. Representative pressurized breadboards were designed, manufactured, and tested. The tests addressed both intrinsic performance, via torque/flexion hysteresis curves, and ergonomic characteristics, via a 'man in the loop' evaluation, involving a suit demonstrator. Tests results completed the trade-off, thus enabling the industrial team to formulate recommendations and propose further development studies. Author (revised)

A93-41428* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
ENHANCED SOFTGOODS STRUCTURES FOR SPACESUIT MICROMETEOROID/DEBRIS PROTECTIVE SYSTEMS
BRIAN REMINGTON, DAVID CADOGAN (ILC Dover, Frederica, DE), and JOSEPH KOSMO (NASA, Johnson Space Center, Houston, TX) Jul. 1992 14 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921258) Copyright

A lightweight, flexible thermal micrometeoroid garment (TMG) design for enhanced space suit micrometeoroid/debris (M/D) protection is described. It will consist of an outer layer comprised of orthofabric, multilayers of aluminized Mylar, and a layer of silicone rubber loaded with micron sized particles of tungsten. The shield layers would fragment and/or vaporize the M/D projectile while the backup sheet would stop the resultant debris cloud. AIAA

A93-41431
SYSTEM INTEGRATION AND VERIFICATION APPROACH FOR THE ENVIRONMENTAL CONTROL SYSTEM OF THE COLUMBUS ATTACHED PRESSURISED MODULE
MASSIMO BRAGHIN and RUGGERO VENERI (Alenia Spazio S.p.A., Turin, Italy) Jul. 1992 9 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992
(SAE PAPER 921261) Copyright

A test approach selected for the functional and performance verification of the Environmental Control System (ECS) of the Attached Pressurized Module (APM) is described. While the ECLSS is tested as an integrated subsystem by using load simulators and a boiler plate, the thermal control subsystem is tested as an integrated engineering model subsystem only after APM EM integration completion. AIAA

A93-41434
PROCESS CONTROL WATER QUALITY MONITOR FOR SPACE STATION FREEDOM - DEVELOPMENT UPDATE
E. L. JEFFERS and J. NOVOTNY (Astro International Corp., Houston, TX) Jul. 1992 23 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by Boeing Defense and Space Group refs
(SAE PAPER 921264) Copyright

The monitoring system being designed for the Space Station Freedom's water reclamation system (called the Process Control Water Quality Monitor, PCWQM) is an untended continuous process water quality monitor which measures conductivity, pH, total organic carbon (TOC), temperature, and the residual iodine biocide concentration in the effluent. This paper describes the PCWQM system, the measurement methodology used, and the solid phase calibration standards. A development test unit containing all major PCWQM components began integrated testing in May 1992. The testing evaluates functional compatibility, materials compatibility, and prototype sensor performance. Results of these evaluations are presented. AIAA

A93-41435
CONTINUOUS MONITORING OF EFFLUENT IODINE LEVELS OF SPACE STATION WATER USING SOLID STATE TECHNOLOGY
DALE R. DOUGHERTY, JOHN NOVOTNY, E. L. JEFFERS (Astro International Corp., Houston, TX), and TOM POORMAN Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921265) Copyright

Space Station Freedom's potable water recycling system will use iodine biocide. A process control water quality monitor will continually measure potable water parameters, including the 2.0 to 6.0 mg/l iodine concentration range. The iodine sensor will be a photometric flow cell that measures iodine's 465 nm radiative absorption band and reports iodine concentration. The expanded ECLSS Preliminary Operational System Test included prototype iodine sensors. A solid state iodine sensor will meet power, weight, reliability, and maintainability requirements associated with the station's redesign. This paper discusses solid state photometric iodine measurement theory and engineering considerations and presents preliminary LED-based sensor test results. Author

A93-41436* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
THE DEVELOPMENT AND TESTING OF A VOLATILE ORGANICS CONCENTRATOR FOR USE IN MONITORING SPACE STATION WATER QUALITY
ITAMAR BODEK, DANIEL J. EHNTHOLT, THOMAS J. STOLKI (Arthur D. Little, Inc., Cambridge, MA), RUDY TRABANINO, LLOYD HINSDALE, JOHANNA WEBB (McDonnell Douglas Space Systems, Huntington Beach, CA), and RICHARD L. SAUER (NASA, Johnson Space Center, Houston, TX) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921266) Copyright

The Volatile Organics Concentrator (VOC) system, designed to attach to a gas chromatograph/mass spectrometer (GC/MS) for the analyses of volatile organic compounds in water on Space Station Freedom, is described. Organic volatiles are collected and concentrated in the VOC by means of two primary solid sorbent tubes and desorbed into the GC/MS system. The paper describes the results of testing the VOC breadboard using a GC/MS system. Evaluations performed on 39 organic compounds recovered from water samples were compared with data for these compounds using direct injection/GC/MS and purge and trap/GC/MS procedures. The results demonstrate that the VOC/GC/MS system's detection limits for the 39 compounds analyzed are comparable to those of the EPA Method 524.2, and for many compounds reaching a factor of 5 lower. AIAA

A93-41437
MEASUREMENT OF FREE AND DISSOLVED GAS CONTENT OF WATER SAMPLES ON SPACE STATION FREEDOM
RANDOLPH W. SCHWEICKART (McDonnell Douglas Space Systems, Huntington Beach, CA) and DAMON C. SMITH (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921267) Copyright

A linear displacement aerometer has been developed for the measurement of the volume percent of free and dissolved gas in water samples. This paper discusses the design and testing of the prototype linear displacement aerometer that was incorporated into the Optical Water Quality Analyzer (OWQA) breadboard, an instrument that is being developed to monitor the quality of water samples on Space Station Freedom. Consumption of liquids containing excessive amounts of free or dissolved gas in microgravity can potentially cause gastrointestinal discomfort. The OWQA aerometer will determine the free and dissolved gas contents of water samples from the Space Station processed water distribution system so that potential health impacts may be assessed prior to consumption. Author

A93-41438* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
EVALUATION OF CAPILLARY ELECTROPHORESIS FOR IN-FLIGHT IONIC CONTAMINANT MONITORING OF SSF POTABLE WATER
PAUL D. MUDGETT, JOHN R. SCHULTZ (Krug Life Sciences, Houston, TX), and RICHARD L. SAUER (NASA, Johnson Space Center, Houston, TX) Jul. 1992 12 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921268) Copyright

Until 1989, ion chromatography (IC) was the baseline technology selected for the Specific Ion Analyzer, an in-flight inorganic water quality monitor being designed for Space Station Freedom. Recent developments in capillary electrophoresis (CE) may offer significant savings of consumables, power consumption, and weight/volume allocation, relative to IC technology. A thorough evaluation of CE's analytical capability, however, is necessary before one of the two techniques is chosen. Unfortunately, analytical methods currently available for inorganic CE are unproven for NASA's target list of anions and cations. Thus, CE electrolyte chemistry and methods to measure the target contaminants must be first identified and optimized. This paper reports the status of a study to evaluate CE's capability with regard to inorganic and carboxylate anions, alkali and alkaline earth cations, and transition metal cations. Preliminary results indicate that CE has an impressive selectivity and trace sensitivity, although considerable methods development remains to be performed. Author

A93-41439* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
THE ANALYTICAL CONTROL PROGRAM FOR THE NASA SPACE STATION FREEDOM ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM (ECLSS) WATER RECOVERY TEST
JAMES D. TATARA and SILVIA MINTON (ION Electronics, Huntsville, AL) Jul. 1992 14 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by NASA refs
(SAE PAPER 921269) Copyright

NASA-Marshall has striven to maximize quality assurance and quality control measures in the course of Water Recovery Test (WRT) development for the Space Station Freedom ECLSS. The WRT was subjected to an independent analytical control program that is governed by the Analytical Control Test Plan and the Microbiological Methods for Water Recovery Testing Plan. Attention is given to analysis results for volatiles, sodium, and conductivity. AIAA

A93-41440
THE APPLICATION OF FILTRATION TECHNOLOGY WITHIN THE WATER PROCESSOR ON BOARD SPACE STATION FREEDOM
PAUL I. KEYSER, GLENN W. HOWARD, JR. (Pall Corp., Glen Cove, NY), JOHN W. STEELE, and ROBERT W. MARSH (Hamilton Standard, Windsor Locks, CT) Jul. 1992 9 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921270) Copyright

Space Station Freedom uses a semi-closed loop recirculating waste water system to regenerate potable water. A specific series of depth and membrane filters can be employed prior to the waste water holding tank to eliminate bacteria at the earliest portion of the Water Processor. Several advantages accrue by using a cold sterilizing method for microbial control. This methodology i) reduces the weight and power requirements needed for a heat sterilizer and exchanger, and ii) significantly reduces biocorrosion and biofilm associated problems. A series of six filters and a two component resin bed was used to process a mixture of laundry water, shower water, and urine distillate in a ratio of 63:28:9 by volume. The final effluent was free of bacteria when grown on R2A agar. Gravimetric analysis was performed on 100 ml of downstream effluent from four filters and compared to the raw water. The proposed filtration scheme throughout the entire Water Processor will contain eleven filters including a final filter sized at 0.04 micron absolute. Author

A93-41441* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
AN ASSESSMENT OF WASTE PROCESSING/RESOURCE RECOVERY TECHNOLOGIES FOR LUNAR/MARS LIFE APPLICATIONS
CHARLES E. VEROSTKO (NASA, Johnson Space Center, Houston, TX), NIGEL J. C. PACKHAM (Lockheed Engineering and Sciences Co., Houston, TX), and DONALD H. HENNINGER (NASA, Johnson Space Center, Houston, TX) Jul. 1992 15 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921271) Copyright

NASA's future manned missions to explore the solar system are by nature of long duration, mandating extensive regeneration of life support consumables from wastes generated in space-based habitats. Long-duration exploration missions would otherwise be prohibitive due to the number and frequency of energy-intensive resupply missions from Earth. Resource recovery is therefore a

critical component of the controlled ecological life support system (CELSS). In order to assess resource recovery technologies for CELSS applications, the Crew and Thermal Systems Division at NASA-Johnson Space Center convened a three-day workshop to assess potential resource recovery technologies for application in a space-based CELSS. This paper describes the methodology of assessing and ranking of these technologies. Recommendations and issues are identified. Evaluations focused on the processes for handling and treatment of inedible plant biomass, human waste, and human generated trash. Technologies were assessed on the basis of safety, reliability, technology readiness, and performance characteristics. Author (revised)

A93-41442
ANAEROBIC TREATMENT OF ORGANIC WASTES FROM CONTROLLED ECOLOGICAL LIFE SUPPORT SYSTEMS
DOUGLAS W. WILLIAMS, ROBERT KULL (California Polytechnic State Univ., San Luis Obispo), and STEVEN H. SCHWARTZKOPF (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by Lockheed Missiles and Space Co., Inc refs
(SAE PAPER 921272) Copyright

This paper describes the results of a project involving an anaerobic digestion system used in treating the human and vegetative wastes from a Controlled Ecological Life Support System (CELSS). The anaerobic digester biologically breaks down the organic matter in the wastes into a mixture of methane gas and carbon dioxide, while significantly reducing the BOD (biological oxygen demand) of the wastewater. A standard waste was formulated consisting of a mixture of swine waste (the surrogate for human feces and urine), green wastes (primarily lettuce), and paper wastes. The equipment used for this project was a 2.7 cubic meter digester tank filled with plastic media and heated to an average temperature of 35 C. The digester was run over period of 200 days and loaded on the average of five days per week. The results over this test period showed a 94 percent reduction in BOD and a 98 percent reduction in suspended solids in the wastewater. Biogas production was approximately 1 cubic meter of biogas per kg of BOD added to the digester per day. This biogas contained an average of 62 percent methane.
Author (revised)

A93-41443* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
CATALYTIC OXIDATION FOR TREATMENT OF ECLSS AND PMMS WASTE STREAMS
JAMES R. AKSE, JOHN THOMPSON, BRYAN SCOTT, CLIFFORD JOLLY (Umpqua Research Co., Myrtle Creek, OR), and DONALD L. CARTER (NASA, Marshall Space Flight Center, Huntsville, AL) Jul. 1992 18 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(Contract NAS8-38038; NAS8-38490)
(SAE PAPER 921274) Copyright

Catalytic oxidation was added to the baseline multifiltration technology for use on the Space Station Freedom in order to convert low-molecular weight organic waste components such as alcohols, aldehydes, ketones, amides, and thiocarbamides to CO2 at low temperature (121 C), thereby reducing the total organic carbon (TOC) to below 500 ppb. The rate of reaction for the catalytic oxidation of aqueous organics to CO2 and water depends primarily upon the catalyst, temperature, and concentration of reactants. This paper describes a kinetic study conducted to determine the impact of each of these parameters upon the reaction rate. The results indicate that a classic kinetic model, the Langmuir-Hinshelwood rate equation for heterogeneous catalysis, can accurately represent the functional dependencies of this rate.
AIAA

A93-41444* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
POST-TREATMENT OF RECLAIMED WASTE WATER BASED ON AN ELECTROCHEMICAL ADVANCED OXIDATION PROCESS
CHARLES E. VEROSTKO (NASA, Johnson Space Center, Houston, TX), OLIVER J. MURPHY, G. D. HITCHENS, CARLOS E. SALINAS, and TOM D. ROGERS (Lynntech, Inc., Bryan, TX) Jul. 1992 13 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921275) Copyright

The purification of reclaimed water is essential to water reclamation technology life-support systems in lunar/Mars habitats. An electrochemical UV reactor is being developed which generates oxidants, operates at low temperatures, and requires no chemical expendables. The reactor is the basis for an advanced oxidation process in which electrochemically generated ozone and hydrogen peroxide are used in combination with ultraviolet light irradiation to produce hydroxyl radicals. Results from this process are presented which demonstrate concept feasibility for removal of organic impurities and disinfection of water for potable and hygiene reuse. Power, size requirements, Faradaic efficiency, and process reaction kinetics are discussed. At the completion of this development effort the reactor system will be installed in JSC's regenerative water recovery test facility for evaluation to compare this technique with other candidate processes. Author (revised)

A93-41445* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
A HYBRID REGENERATIVE WATER RECOVERY SYSTEM FOR LUNAR/MARS LIFE SUPPORT APPLICATIONS
CHARLES E. VEROSTKO, MARYBETH A. EDEEN (NASA, Johnson Space Center, Houston, TX), and NIGEL J. C. PACKHAM (Lockheed Engineering and Sciences Co., Houston, TX) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921276) Copyright

Long-duration manned space missions will require integrated biological and physicochemical processes for recovery of resources from wastes. This paper discusses a hybrid regenerative biological and physicochemical water recovery system designed and built at NASA's Crew and Thermal Systems Division at Johnson Space Center. The system is sized for a four-person crew and consists of a two-stage, aerobic, trickling filter bioreactor; a reverse osmosis system; and a photocatalytic oxidation system. The system was designed to accommodate high organic and inorganic loadings and a low hydraulic loading. The bioreactor was designed to oxidize organics to carbon dioxide and water; the reverse osmosis system reduces inorganic content to potable quality; and the photocatalytic oxidation unit removes residual organic impurities (part per million range) and provides in situ disinfection. The design and performance of the hybrid system for producing potable/hygiene water is described. Aspects of the system such as closure, automation and integration are discussed and preliminary results presented. Author (revised)

A93-41446
IMMOBILIZED CELL BIOREACTORS FOR WATER RECLAMATION - PROCESS STABILITY AND EFFECT OF REACTOR DESIGN
GLENN E. PETRIE, BERIT G. DISMER, EDWARD F. ZINGER (Allied-Signal Research and Technology, Des Plaines, IL), and MAURENA S. NACHEFF-BENEDICT (Allied-Signal Aerospace, Torrance, CA) Jul. 1992 12 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by Allied-Signal Aerospace and Allied-Signal Engineered Materials refs
(SAE PAPER 921277) Copyright

Immobilized cell bioreactor (ICB) technology is being investigated under a multiyear, company-funded program to evaluate its applicability as a primary water processor for treatment of wastewater streams in a regenerative life support system (RLSS). Two aspects of the ongoing ICB research are described: (1)

performance stability over an extended time period, and (2) new reactor designs. Two packed-bed bioreactors were operated over 7 months at a hydraulic retention time (HRT) of 24 hours and exhibited consistent performance throughout this period in terms of total organic carbon degradation, urea degradation, and solids production. However, it is desirable to lower the required HRT, by increasing the overall processing rate, in order to minimize size and weight of an ICB for a life support system. Two alternate scale bioreactor designs were investigated and their effect on the HRT determined. A greater than fourfold decrease in HRT compared with previous bioreactors is reported. Author (revised)

A93-41449
ENVIRONMENTAL CONTROL OF THE MINI PRESSURIZED LOGISTIC MODULE
CESARE LOBASCIO, ANGELO DENARO, and RENATO D'AURIA (Alenia Spazio S.p.A., Turin, Italy) Jul. 1992 14 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992
(SAE PAPER 921281) Copyright

The Mini Pressurized Logistic Module (MPLM)is designed to transport supplies and return cargo requiring a pressurized environment to and from the Space Station Freedom (SSF) via the National Space Transportation System (NSTS) Shuttle. The MPLM provides accommodation for a number of cargo racks, including two Freezer/Refrigerators (F/Rs) and one subsystem rack. The maintenance of the habitable conditions for the crew and the control of the MPLM thermal environment are carried out by the Environmental Control and Life Support System (ECLSS) and the Thermal Control System (TCS). The ECLSS and TCS functional concepts are tailored to the peculiarities of the MPLM design, based on mass and volume minimization, maximum simplification, and exploitation of the resources available at the SSF interface. This paper provides an overview of the ECLSS and TCS design features and components, describing the results of the main tradeoffs performed by Alenia Spazio in the definition phase of the Phase B MPLM baseline (Mid-Term Review).
Author (revised)

A93-41450
EFFECTS OF AIR BUBBLE CONTAMINATION IN RECIRCULATING WATER LOOP
ROBERTO ORLANDO and MARINO FERRARA (Microtecnica S.p.A., Turin, Italy) Jul. 1992 8 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992
(SAE PAPER 921282) Copyright

Long life in space of the Columbus recirculating water transport loop indicates probability that air bubble contamination will inadvertently be added to the loop during service revision, or repair procedures. This paper describes the results of tests run to simulate the effects of bubble contamination on the operation in zero gravity of a recirculating water loop. All major components of the loop were installed with their water inlet and outlet connections at the top to prevent bubbles from being separated and stored in the components. In this way the bubbles were encouraged to recirculate in the loop in the manner expected in space with zero g operation. Maximum air injection without adverse pump operation was determined. A brief trade-off of prospective bubble trap concepts is presented, and a preliminary investigation of a hydrophobic membrane bubble separator for this application is discussed.
Author

A93-41451
HAZARD AND RISK ASSESSMENT FOR SURFACE COMPONENTS OF A LUNAR BASE CONTROLLED ECOLOGICAL LIFE SUPPORT SYSTEM
S. SCHWARTZKOPF (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921285) Copyright

Results are presented of an analysis of the two greatest potential hazards for the lunar-base Controlled Ecological Life Support System (CELLS) to be built on the lunar surface or just beneath it: the ionizing radiation and the danger of meteoroid penetration. The analysis defines the degree of risk associated with each hazard, specifically with regard to the feasibility of using an inflatable surface structure for CELLS application. It is shown that chronic exposure to galactic cosmic rays does not present a hindrance to the concept of constructing a plant growth subsystem on the surface of the moon. However, the analysis indicated that, even for a small plant growth system such as that anticipated for a four-person crew, there is at least a 1 percent chance of a small meteoroid strike. AIAA

A93-41452* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
ADVANCED LIFE SUPPORT SYSTEMS IN LUNAR AND MARTIAN ENVIRONMENTS UTILIZING A HIGHER PLANT BASED ENGINEERING PARADIGM
DENNIS CHAMBERLAND (NASA, Kennedy Space Center, Cocoa Beach, FL) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921286) Copyright

The paper describes a higher-plant-based engineering paradigm for advanced life support in a Controlled Ecological Life Support System (CELSS) on the surface of the moon or Mars, called the CELSS Breadboard Project, designed at John F. Kennedy Space Center. Such a higher-plant-based system would use the plants for a direct food source, gas exchange, water reclamation, and plant residuals in a complex biological resource recovery scheme. The CELSS Breadboard Project utilizes a 'breadboard' approach of developing independent systems that are evaluated autonomously and are later interconnected. Such a scheme will enable evaluation of life support system methodologies tested for their efficiency in a life support system for habitats on the moon or Mars. AIAA

A93-41453* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CONSUMABLES AND WASTES ESTIMATIONS FOR THE FIRST LUNAR OUTPOST
RONALD L. A. THEIS, MARK G. BALLIN (NASA, Ames Research Center, Moffett Field, CA), and MARTHA F. EVERT (Lockheed Engineering & Sciences Co., Houston, TX) Jul. 1992 12 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921287) Copyright

The First Lunar Outpost mission is a design reference mission for the first human return to the moon. This paper describes a set of consumables and waste material estimations made on the basis of the First Lunar Outpost mission scenario developed by the NASA Exploration Programs Office. The study includes the definition of a functional interface framework and a top-level set of consumables and waste materials to be evaluated, the compilation of mass flow information from mission developers supplemented with information from the literature, and the analysis of the resulting mass flow information to gain insight about the possibility of material flow integration between the moon outpost elements. The results of the study of the details of the piloted mission and the habitat are used to identify areas where integration of consumables and wastes across different mission elements could provide possible launch mass savings. AIAA

A93-41463* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
DEVELOPMENT OF A REGENERABLE METAL OXIDE SHEET MATRIX CO2 REMOVAL SYSTEM
TIMOTHY A. NALETTE, THOMAS P. FILBUM (Hamilton Standard, Windsor Locks, CT), and ROBERT J. CUSICK (NASA, Johnson Space Center, Houston, TX) Jul. 1992 8 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992
(Contract NAS9-17822)
(SAE PAPER 921298) Copyright

NASA-Johnson has guided the development of a nonventing Metal Oxide Regenerable EMU CO2 Removal Subsystem (MORES) which employs a catalyzed, Ag-based metal oxide to achieve CO2 removal during EVA, while requiring no supplemental cooling. Regeneration is then easily obtained by means of cabin air, in a simple hot-air process. The MORES technology has been demonstrated in the case of a full size EMU contaminant control cartridge employing a conventional packed bed, as well as an improved sheet matrix configuration. AIAA

A93-41464* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PORTABLE LIFE SUPPORT SYSTEM REGENERATIVE CARBON DIOXIDE AND WATER VAPOR REMOVAL BY METAL OXIDE ABSORBENTS PREPROTOTYPE HARDWARE DEVELOPMENT AND TESTING
JOAN M. HART, JOSEPH B. BORGHESE (Allied-Signal Aerospace, Torrance, CA), CRAIG H. CHANG (Allied-Signal Research and Technology, Des Plaines, IL), and ROBERT J. CUSICK (NASA, Johnson Space Center, Houston, TX) Jul. 1992 12 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(Contract NAS9-17900)
(SAE PAPER 921299) Copyright

NASA-Johnson has acquired a preprototype/full-scale metal oxide CO2 and humidity remover (MOCHR), together with its regeneration module. Tests conducted prior to delivery by the MOCHR's manufacturer have demonstrated the concurrent removal of H2O and CO2 at rates, and under conditions, that are applicable to EVA Portable Life Support Systems. AIAA

A93-41472* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
BIOFILM FORMATION AND CONTROL IN A SIMULATED SPACECRAFT WATER SYSTEM - THREE YEAR RESULTS
JOHN R. SCHULTZ, DAVID T. FLANAGAN, REBEKAH J. BRUCE, PAUL D. MUDGETT, SANDRA E. CARR, JEFFREY A. RUTZ, M. H. HULS (Krug Life Sciences, Inc., Houston, TX), RICHARD L. SAUER, and DUANE L. PIERSON (NASA, Johnson Space Center, Houston, TX) Jul. 1992 15 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921310) Copyright

Two simulated spacecraft water systems are being used to evaluate the effectiveness of iodine for controlling microbial contamination within such systems. An iodine concentration of about 2.0 mg/L is maintained in one system by passing ultrapure water through an iodinated ion exchange resin. Stainless steel coupons with electropolished and mechanically-polished sides are being used to monitor biofilm formation. Results after three years of operation show a single episode of significant bacterial growth in the iodinated system when the iodine level dropped to 1.9 mg/L. This growth was apparently controlled by replacing the iodinated ion exchange resin, thereby increasing the iodine level. The second batch of resin has remained effective in controlling microbial growth down to an iodine level of 1.0 mg/L. SEM indicates that the iodine has impeded but may have not completely eliminated the formation of biofilm. Metals analyses reveal some corrosion in the iodinated system after 3 years of continuous exposure. Significant microbial contamination has been present continuously in a parallel noniodinated system since the third week of operation. Author

A93-41473 National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
BIODETERIORATION OF MATERIALS IN WATER RECLAMATION SYSTEMS
TIM FORD, JAMES S. MAKI, and RALPH MITCHELL (Harvard Univ., Cambridge, MA) Jul. 1992 7 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(Contract NCC8-17; NCC2-628)
(SAE PAPER 921311) Copyright

The chemicals produced by the microbial processes involved in the 'biofilms' which form on the surfaces of manned spacecraft water reclamation systems encompass both metals and organic poisons; both are potential hazards to astronaut health and the growth of the plants envisioned for closed-cycle life support systems. Image analysis is here shown to be a very useful technique for the study of biofilm formation on candidate water-processor materials for Space Station Freedom. The biodeterioration of materials exposed to biofilms can be swiftly evaluated by means of electrochemical impedance spectroscopy. AIAA

A93-41474* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
USE OF SORPTION TECHNOLOGY FOR TREATMENT OF HUMIDITY CONDENSATE FOR POTABLE WATER
SUNDARA R. M. AJJARAPU and J. M. SYMONS (Houston Univ., TX) Jul. 1992 20 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(Contract NAG9-284)
(SAE PAPER 921312) Copyright

This research focused on the testing of the original potable water processor aboard Space Station Freedom that was to produce potable water from the humidity condensate and additional water generated by carbon dioxide reduction. Humidity condensate was simulated by an influent water model 'Ersatz'. The humidity condensate was treated with multifiltration (MF) beds that consisted of a train of sorption beds (referred to as 'Unibed') designed to remove specific contaminants. For the complete simulated MF system runs tested for 100 bed volumes (BV) (volume processed/total column volume), 0.6 percent of the TOC was removed by the SAC/IRN 77 (Strong Acid Cation exchange resin), 39.6 percent of the total organic carbon (TOC) was removed by the WBA/IRA 68 (Weak Base Anion exchange resin), 13.2 percent of the TOC was removed by activated carbon adsorption (580-26), and the remaining sorbent media acted as polishing units to remove an additional 1.6 percent of the TOC at steady state. At steady state, 45 percent of the influent TOC passed through the MF bed. Author

A93-41475* National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
DETERMINATION OF ORGANIC CARBON AND IONIC ACCOUNTABILITY OF VARIOUS WASTE AND PRODUCT WATERS DERIVED FROM ECLSS WATER RECOVERY TESTS AND SPACELAB HUMIDITY CONDENSATE
DONALD L. CARTER (NASA, Marshall Space Flight Center, Huntsville, AL), HAROLD COLE, MARK HABERCOM (Boeing Co., Missiles and Space Div., Huntsville, AL), and GUY GRIFFITH (Sverdrup Technology, Inc., Tullahoma, TN) Jul. 1992 26 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921313) Copyright

The development of a closed-loop water recovery system for Space Station Freedom involves many technical challenges associated with contaminant removal. Attention is presently given to the characterization of contaminants constituting total organic carbon (TOC), and to the Hubaux and Vos (1970) statistical model for low level TOC that has been employed. A tabulation is given for TOC accountability in the case of both potable and hygiene waters. AIAA

A93-41478* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
REGENERABLE MICROBIAL CHECK VALVE - LIFE CYCLE TESTS RESULTS
JAMES E. ATWATER, RICHARD R. WHEELER, JR., J. T. OLIVADOTI (Umpqua Research Co., Myrtle Creek, OR), RICHARD L. SAUER (NASA, Johnson Space Center, Houston, TX), and DAVID T. FLANAGAN (Krug Life Sciences, Inc., Houston, TX) Jul. 1992 12 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs

(Contract NAS9-18361)
(SAE PAPER 921316) Copyright

Life cycle regeneration testing of the Microbial Check Valve (MCV) that is used on the Shuttle Orbiter to provide microbial control of potable water is currently in progress. Four beds are being challenged with simulated reclaimed waters and repeatedly regenerated. Preliminary results indicate that contaminant systems exhibit unique regeneration periodicities. Cyclic throughput diminishes with increasing cumulative flow. It is considered to be feasible to design a regenerable MCV system which will function without human intervention and with minimal resupply penalty for the 30 year life of the Space Station. AIAA

A93-41480
GRAY WATER RECYCLING WITH A UNIQUE VAPOR COMPRESSION DISTILLATION (VCD) DESIGN
M. A. FRIEDMAN, T. E. STYCZYNSKI, S. H. SCHWARTZKOPF (Lockheed Missiles & Space Co., Inc., Sunnyvale, CA), B. W. TLEIMAT, and M. C. TLEIMAT Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921318) Copyright

This paper describes the design and test of a gray water recycling system based on VCD using a patented evaporator. The system has previously been tested using sea water and agricultural runoff as the feed, but gray water had never been tested. The work covered in this paper evaluated the utility and performance potential of VCD in recycling gray water in partial- and full-gravity environments. The gray water recycling test used a defined gray water simulant as the input to the VCD system. Engineering data were taken and samples of the product distilled water, the waste brine, and original feed were collected as the operating parameters of the system were varied. Results show that this is an extremely efficient recycling system that produces excellent quality distilled water with recovery efficiencies of over 95 percent. Depending on the operating conditions, the energy consumption varied from 32 to 64 Watt-hours/kg (120 to 240 W-hr/gal) of condensate produced. Author (revised)

A93-41482
MEMBRANE TECHNOLOGY FOR ZERO GRAVITY LIFE SUPPORT SYSTEMS
ALAN D. WILLIAMS and JEFFREY J. FASZCZA (Hamilton Standard, Windsor Locks, CT) Jul. 1992 8 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921320) Copyright

Membrane technology development for both gas separation and pervaporation separation processes aimed at maximizing membrane selectivity while maintaining high permeation rates is addressed. Current technology can be extended to develop new membrane materials for space life support applications in three areas, namely, thin film composites, immobilized liquid membranes, and volatile rejection membranes. It is concluded that the state-of-the-art membrane technology in these three areas is applicable to zero gravity life support systems including CO2 removal and water purification. AIAA

A93-41483* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
OPERATION OF A BREADBOARD LIQUID-SORBENT/MEMBRANE-CONTACTOR SYSTEM FOR REMOVING CARBON DIOXIDE AND WATER VAPOR FROM AIR
SCOTT B. MCCRAY, ROD RAY, DAVID D. NEWBOLD, DOUGLAS L. MILLARD, DWAYNE T. FRIESEN (Bend Research, Inc., OR), and SANDRA FOERG (NASA, Johnson Space Center, Houston, TX) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992
(Contract NAS9-18348)
(SAE PAPER 921321) Copyright

Processes to remove and recover carbon dioxide (CO2) and water vapor from air are essential for successful long-duration space missions. This paper presents results of a developmental program focused on the use of a liquid-sorbent/membrane-contactor (LSMC) system for removal of CO2 and water vapor from air. In this system, air from the spacecraft cabin atmosphere is circulated through one side of a hollow-fiber membrane contactor. On the other side of the membrane contactor is flowed a liquid sorbent, which absorbs the CO2 and water vapor from the feed air. The liquid sorbent is then heated to desorb the CO2 and water vapor. The CO2 is subsequently removed from the system as a concentrated gas stream, whereas the water vapor is condensed, producing a water stream. A breadboard system based on this technology was designed and constructed. Tests showed that the LSMC breadboard system can produce a CO2 stream and a liquid-water stream. Details are presented on the operation of the system, as well as the effects on performance of variations in feed conditions. Author (revised)

A93-41484* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A NOVEL MEMBRANE DEVICE FOR THE REMOVAL OF WATER VAPOR AND WATER DROPLETS FROM AIR
ROD RAY, DAVID D. NEWBOLD, SCOTT B. MCCRAY, DWAYNE T. FRIESEN (Bend Research, Inc., OR), and MARK KLISS (NASA, Ames Research Center, Moffett Field, CA) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(Contract NAS2-13345)
(SAE PAPER 921322) Copyright

One of the key challenges facing NASA engineers is the development of systems for separating liquids and gases in microgravity environments. In this paper, a novel membrane-based phase separator is described. This device, known as a water recovery heat exchanger (WRHEX), overcomes the inherent deficiencies of current phase-separation technology. Specifically, the WRHEX cools and removes water vapor or water droplets from feed-air streams without the use of a vacuum or centrifugal force. As is shown in this paper, only a low-power air blower and a small stream of recirculated cool water is required for WRHEX operation. This paper presents the results of tests using this novel membrane device over a wide range of operating conditions. The data show that the WRHEX produces a dry air stream containing no entrained or liquid water - even when the feed air contains water droplets or mist. An analysis of the operation of the WRHEX is presented. Author (revised)

A93-41485
RECOVERING POTABLE WATER FROM WASTEWATER IN SPACE PLATFORMS BY LYOPHILIZATION
PETER J. HOLLAND, CAROLYN L. MILLER, DONALD M. BIRD, JENNY E. YUNG, and DORAL E. SANDLIN (U.S. Air Force Academy, Colorado Springs, CO) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921323) Copyright

The USAFA research on lyophilization of urine and the NASA standard wastewater cocktail is reviewed. Bacteriological results show that normal flora from the urinary tract does not survive lyophilization. Formation of capsules do not protect the host bacterium from the environmental stresses exerted by lyophilization. Physicochemical results reveal that NASA Space Station Freedom standards were met or exceeded in all tested parameters except that of ammonia-nitrogen in the product water generated from the raw blended urine. Lyophilization recovered about 97 and 95 percent of the water from humane urine and the wastewater cocktail, respectively. AIAA

A93-41493
RECENT REGENERATIVE ECLSS TECHNOLOGY DEVELOPMENTS IN EUROPE
H. PREISS (Dornier GmbH, Friedrichshafen, Germany), G. TAN, and C. SAVAGE (ESTEC, Noordwijk, Netherlands) Jul. 1992 10 p. SAE, International Conference on Environmental Systems,

22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921332) Copyright

The status of the preliminary breadboarding based on a steam desorbed solid amine concentrator and a Sabatier reactor is discussed. Test results on a five cell fixed alkaline electrolyzer for regenerative fuel cell applications are reported. Possible application of vacuum desorbed solid amine for regenerative CO2 control in HERMES and COLUMBUS is addressed. AIAA

A93-41497
LIFE SUPPORT AND HABITABILITY MANUAL ESA PSS-03-406
ROBIN C. HUTTENBACH (Nelson Space Services, Ltd., London, United Kingdom) Jul. 1992 16 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 Research supported by ESA refs
(SAE PAPER 921338) Copyright

The paper describes some of the features of a reference manual to be issued by the European Space Agency that will form part of a set of standards covering the subjects of environmental control, life support, habitability, and human factors. The Manual contains information on the general requirements of life support and habitability and the missions that will drive its associated technologies. It is formatted as a series of individual data sheets that can be updated regularly and which are designed to accommodate inputs from other organizations and individuals. It also includes details of promising experimental work and theoretical concepts, as well as historical reviews that will help to guide the selection of technologies and the design of new systems. The paper presents examples from the Manual, which highlight aspects of a systems approach to life support. Trade-off methods that can be used to evaluate competing technologies and their combinations at sub-system and systems level are also described. Author (revised)

A93-41503* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PERFORMANCE EVALUATION OF CANDIDATE SPACE SUIT ELEMENTS FOR THE NEXT GENERATION ORBITAL EMU
PHILIP R. WEST and STEPHANIE V. TRAUSCH (NASA, Johnson Space Center, Houston, TX) Jul. 1992 15 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921344) Copyright

The AX-5 all metallic, multibearing technologies developed at the Ames Research Center and the Mk III fabric and metallic technologies developed at the Johnson Space Center were evaluated using the current Space Shuttle space suit technologies as a baseline. Manned evaluations were performed in the Weightless Environment Training Facility and KC-135 zero-gravity aircraft. Joint torque, range, cycle life, and environmental protection characteristics were analyzed during unmanned tests. Both numerical results and test subject comments on performance are presented. AIAA

A93-41504* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SPACE SHUTTLE CREW COMPARTMENT DEBRIS-CONTAMINATION
JERRY R. GOODMAN and LEOPOLDO J. VILLARREAL (NASA, Johnson Space Center, Houston, TX) Jul. 1992 12 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992
(SAE PAPER 921345) Copyright

Remedial actions undertaken to reduce debris during manned flights and ground turnaround operations at Kennedy Space Center and Palmdale are addressed. They include redesign of selected ground support equipment and Orbiter hardware to reduce particularization/debris generation; development of new detachable filters for air-cooled avionics boxes; application of tape-on screens to filter debris; and implementation of new Orbiter maintenance and turnaround procedures to clean filters and the crew compartment. Most of these steps were implemented before the return-to-flight of STS-26 in September 1988 which resulted in improved crew compartment habitability and less potential for equipment malfunction. AIAA

A93-41505
TEST OF THE SHUTTLE EXTENDED DURATION ORBITER (EDO) WASTE COLLECTION SUBSYSTEM (WCS)
DONALD W. RETHKE (Hamilton Standard, Windsor Locks, CT) Jul. 1992 14 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921346) Copyright

A new concept for human waste collection, compaction, and storage has been developed to accommodate the planned longer flight durations required for the Shuttle. The new commode features brushless dc motor driven fan/separators for urine collection, individual disposable bags for fecal collection with mechanized compaction, and in-flight removable canisters that allow natural biodegradation of the stored solid waste. Results of the EDO WCS commode development and evaluation tests performed in the NASA JSC Houston show that the unit operates properly to collect liquid and solid waste. AIAA

A93-41506* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SPACE SHUTTLE ORBITER OXYGEN PARTIAL PRESSURE SENSING AND CONTROL SYSTEM IMPROVEMENTS
ROBERT F. FRAMPTON (Carleton Technologies, Inc., Orchard Park, NY), DENNIS M. HOY (NASA, Johnson Space Center, Houston, TX), KEVIN J. KELLY (Rockwell International Corp., Seal Beach, CA), and JAMES J. WALLESHAUSER (Carleton Technologies, Inc., Orchard Park, NY) Jul. 1992 15 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921347) Copyright

A program aimed at developing a new PPO2 oxygen sensor and a replacement amplifier for the Space Shuttle Orbiter is described. Experimental design methodologies used in the test and modeling process made it possible to enhance the effectiveness of the program and to reduce its cost. Significant cost savings are due to the increased lifetime of the basic sensor cell, the maximization of useful sensor life through an increased amplifier gain adjustment capability, the use of streamlined production processes for the manufacture of the assemblies, and the refurbishment capability of the replacement sensor. AIAA

A93-41507* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SHUTTLE ORBITER ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM - FLIGHT EXPERIENCE
H. E. WINKLER (NASA, Johnson Space Center, Houston, TX) Jul. 1992 8 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921348) Copyright

This paper describes the overall design of the Shuttle Orbiter Environmental Control and Life Support System (ECLSS). The Orbiter ECLSS consists of six major subsystems which accomplish the functions of providing a habitable pressurized cabin atmosphere and removing gaseous contaminants, controlling the temperature of the cabin and vehicle components within acceptable ranges, providing fire detection and suppression capability, maintaining a supply of potable water, collecting and removing metabolic waste materials, and providing utilities and access for extravehicular activity. The operational experience is summarized for the 45 space flights accomplished to date during which the Orbiter ECLSS has been demonstrated to perform reliably, and has proved to have the flexibility to meet a variety of mission needs. Significant flight problems are described, along with the design or procedure changes which were implemented to resolve the problems. Author

A93-41509
AIR HANDLING AND ATMOSPHERE CONDITIONING SYSTEMS FOR MANNED SPACECRAFT - A DESIGN AND PERFORMANCE DATA SURVEY
CHARLES E. MARTIN and ARTHUR K. MCCORMICK, III (McDonnell Douglas Space Systems, Huntington Beach, CA) Jul. 1992 28 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921350) Copyright

As the complexity of manned spacecraft increases, close consideration of Environmental Control and Life Support (ECLS) systems design becomes important. Mission design topics and flight performance data for a subset of the overall ECLS system, the Air Handling and Atmosphere Conditioning (AH&AC) system, are presented to aid in designing systems for future manned missions. Included are such topics as crew habitable volumes, air circulation velocities, atmospheric pressures, electrical component and metabolic cooling, ventilation fan designs, and contaminant removal systems. The condensed information in this paper represents the first step in a much larger internal study with the goal of optimizing the design and efficiency of physical/chemical life support systems, using flight data and 'lessons learned' to support this goal. Author

A93-41510* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
WATER RECLAMATION TECHNOLOGY DEVELOPMENT FOR FUTURE LONG RANGE MISSIONS
MICHAEL T. FLYNN, KARL AMO, T. M. HIGHTOWER, and JOHN FISHER (NASA, Ames Research Center, Moffett Field, CA) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921351) Copyright

This paper covers the development of computer simulation models of the Vapor Compression Distillation (VCD) process, the Super Critical Water Oxidation (SCWO) process, and two versions of a Vapor Phase Catalytic Ammonia Reduction (VPCAR) process. These process level models have combined into two Integrated Water Reclamation Systems (IWRS). Results from these integrated models, in conjunction with other data sources, have been used to develop a preliminary comparison of the two systems. Also discussed in this paper is the development of a Vapor Phase Catalytic Ammonia Reduction teststand and the development of a new urine analog for use with the teststand and computer models. Author

A93-41511* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
MODELING OF MEMBRANE PROCESSES FOR AIR REVITALIZATION AND WATER RECOVERY
KEVIN E. LANGE (Lockheed Engineering & Sciences Co., Houston, TX), SANDRA L. FOERG, and LIESE A. DALL-BAUMAN (NASA, Johnson Space Center, Houston, TX) Jul. 1992 14 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921352) Copyright

Gas-separation and reverse-osmosis membrane models are being developed in conjunction with membrane testing at NASA JSC. The completed gas-separation membrane model extracts effective component permeabilities from multicomponent test data, and predicts the effects of flow configuration, operating conditions, and membrane dimensions on module performance. Variable feed- and permeate-side pressures are considered. The model has been applied to test data for hollow-fiber membrane modules with simulated cabin-air feeds. Results are presented for a membrane designed for air drying applications. Extracted permeabilities are used to predict the effect of operating conditions on water enrichment in the permeate. A first-order reverse-osmosis model has been applied to test data for spiral wound membrane modules with a simulated hygiene water feed. The model estimates an effective local component rejection coefficient under pseudosteady-state conditions. Results are used to define requirements for a detailed reverse-osmosis model. Author (revised)

A93-41512
HIGH-RECOVERY LOW-PRESSURE REVERSE OSMOSIS
CAL C. HERRMANN (Bionetics Corp., Moffett Field, CA) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921353) Copyright

Membrane performance parameters have been obtained for high water recovery operation in the pressure range up to 1.4 MPascals (200 psig) for system modeling. Simple equations can be fitted to these measurements, from which RO system performance can be predicted or simulated as part of a model of system performance. A single-pump configuration with feedback has been found useful in reaching high brine osmotic pressures in continuous-flow operation. Enhanced brine concentration as well as an enhanced fraction of product/feed water recovery can be obtained by recycling a second-stage permeate of intermediate quality. For spaceflight recycling of hygiene water this permits lower pressure-vessel ratings, or higher water recovery, or both. Author

A93-41513
COMPUTER MODELING OF THE VARIABLE PRESSURE GROWTH CHAMBER USING THE CASE/A SIMULATION PACKAGE
CARL D. MCFADDEN (McDonnell Douglas Space Systems, Houston, TX) and ADAM M. MILLER (McDonnell Douglas Space Systems, Huntington Beach, CA) Jul. 1992 8 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921354) Copyright

A computer simulation of the variable pressure growth chamber (VPGC) located at the NASA Johnson Space Center has been developed using an expanded version of the Computer-Aided Systems Engineering and Analysis (CASE/A) simulation package. The VPGC is a pressure chamber that has been outfitted to support the growth of approximately 10.6 sq m of plants in an enclosed environment of approximately 27 cu m. CASE/A is a physical/chemical system-level simulation package originally developed to model the life support systems of Space Station Freedom. The expanded version of CASE/A extends the simulation package by including biological components, primarily plant growth algorithms. The configuration, modeling methods and verification of the CASE/A Variable Pressure Growth Chamber model are described. Performance estimates generated from the model are compared to data from recent lettuce growth experiments in the VPGC. Author (revised)

A93-41514 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
PLANT CANOPY TRANSPIRATION IN BIOREGENERATIVE LIFE SUPPORT SYSTEMS - THE LINK BETWEEN MECHANISTIC AND EMPIRICAL MODELS
ROBERT J. SIRKO (McDonnell Douglas Space Systems, Huntington Beach, CA), ANN C. MCCORMACK (NASA, Ames Research Center, Moffett Field, CA), and MARYBETH A. EDEEN (NASA, Johnson Space Center, Houston, TX) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921355) Copyright

A model of water transpiration in a plant canopy that combines two approaches is presented. The first approach is to account for underlying physical processes, while the second is to empirically incorporate transpiration data now being generated at the Johnson Center Variable Pressure Growth Chamber. The two approaches, physical modeling and data analysis, make it possible to produce a model that is more robust than either the standard first-principles model or a straightforward empirical model. It is shown that the present transpiration model is able to efficiently capture the dynamic behavior of the plant canopy over the entire range of environmental parameters now envisioned to be important in an operating

controlled ecological life support system (CELSS). Examples of the use of this model in assessing plant canopy dynamics and CELSS design options are also presented. AIAA

A93-41515* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
PLANT GROWTH MODELING AT THE JSC VARIABLE PRESSURE GROWTH CHAMBER - AN APPLICATION OF EXPERIMENTAL DESIGN
ADAM M. MILLER (McDonnell Douglas Space Systems, Huntington Beach, CA), MARYBETH EDEEN (NASA, Johnson Space Center, Houston, TX), and ROBERT J. SIRKO (McDonnell Douglas Space Systems, Huntington Beach, CA) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921356) Copyright

This paper describes the approach and results of an effort to characterize plant growth under various environmental conditions at the Johnson Space Center variable pressure growth chamber. Using a field of applied mathematics and statistics known as design of experiments (DOE), we developed a test plan for varying environmental parameters during a lettuce growth experiment. The test plan was developed using a Box-Behnken approach to DOE. As a result of the experimental runs, we have developed empirical models of both the transpiration process and carbon dioxide assimilation for Waldman's Green lettuce over specified ranges of environmental parameters including carbon dioxide concentration, light intensity, dew-point temperature, and air velocity. This model also predicts transpiration and carbon dioxide assimilation for different ages of the plant canopy. Author

A93-41516* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
TESTS CHARACTERIZING BIOPROCESSOR HARDWARE FOR ANALYTICAL MODELING
S. GUSTAVINO (McDonnell Douglas Space Systems, Huntington Beach, CA) and A. MCCORMACK (NASA, Ames Research Center, Moffett Field, CA) Jul. 1992 8 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921357) Copyright

The tests outlined in this paper were used to characterize the hardware components of the Salad Machine, a small NASA-developed bioprocessor. The data from these tests are presented, and the methods by which this data can be integrated into system mathematical models are briefly discussed. The subsystems and physical processes discussed include the lighting system, the air loop (condensing heat exchanger and the blower), heat transfer to the surroundings, and leakage. Through this effort it was learned that in the development of a test protocol, care should be taken to order the tests such that environmental parameters, particularly humidity, require as few large adjustments as possible. Sensor calibration and installation take a substantial amount of time, which should be built into the test schedule. Two properties were particularly hard to quantify: the air flow rate and the energy from the lighting system entering into the growth volume. Flow rate can be measured using the appropriate device for the system configuration and airflow. Lighting system radiation level was measured using three methods. The results of these methods varied substantially, putting off conclusive quantification of this value. Author (revised)

A93-41517* National Aeronautics and Space Administration, Washington, DC.
NASA SPECIALIZED CENTER FOR RESEARCH AND TRAINING (NSCORT) IN SPACE ENVIRONMENTAL HEALTH
THOMAS W. CLARKSON, MARK J. UTELL (Rochester Univ., NY), GEORGE W. MORGENTHALER (Colorado Univ., Boulder), RALPH EBERHARDT (Martin Marietta Civil Space & Communications, Denver, CO), and ROBERT RABIN (Center for Space and Advanced Technology, Fairfax, VA) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(Contract NAGW-2356)
(SAE PAPER 921358) Copyright

Activities of the Center for Space Environmental Health (CSEH), one of several NSCORTs supported by NASA in order to advance knowledge in environmental health in space habitats, are reviewed. Research in environmental health will define the standards or requirements needed to protect human health. This information will affect mission plans and the design of space habitats. This reseach will study unique contaminant stresses and lead to risk models for human health and performance. AIAA

A93-41518
BIOMASS PRODUCTIVITY AND SUSTAINABILITY OF A BIOREGENERATIVE LIFE-SUPPORT SYSTEM
CARY A. MITCHELL, LOUIS A. SHERMAN, PAUL M. HASEGAWA, RAYMOND A. BRESSAN, THOMAS K. HODGES, S. S. NIELSEN, PHILIP E. NELSON, and MICHAEL R. LADISCH (Purdue Univ., West Lafayette, IN) Jul. 1992 9 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992
(SAE PAPER 921359) Copyright

Energy budgets for future Controlled Ecological Life-Support Systems (CELSS) must balance not only with respect to primary productivity (i.e., photosynthesis) vs utilization steps (human maintenance plus preparative and recycling processes), but also with respect to necessary and desired nonlife-support activities of crews (e.g., exploration, research). Present objectives of the NSCORT program at Purdue University include identification of critical paths for biomass conversion to desired forms with energetics and rate-constant properties that are compatible with life-support sustainability within a CELSS Physico-chemical recycling systems working in conjunction with bioregenerative ones likely will be required to keep time constants of critical processes within reasonable limits. Author

A93-41519
CONTAMINANT DISTRIBUTION AND ACCUMULATION IN WATER RECYCLE SYSTEMS
JOANN SILVERSTEIN, JON R. SCHULZ, ROBERT BARKLEY, GAIL M. BRION, and CHARLES HURST (Colorado Univ., Boulder) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921360) Copyright

Water contaminant distribution research conducted as part of the activities of the Center For Space Environmental Health, a NASA Specialized Center of Research and Training, is reviewed. The research is based on a scaled-down physical model of a water recycle system to analyze and model four 'indicator' contaminants: viruses and bacteria, nitrogen species, and selected organic and inorganic compounds. The water recycle test bed encompasses individual water treatment processes linked in a closed loop, and spiked with chemical and biological contaminants. A systems approach was used to define experiments and data which can be used to characterize the long-term, overall performance of the test bed. AIAA

A93-41521
GENERATION OF IODINE DISINFECTION BY-PRODUCTS (IDP'S) IN A WATER RECYCLE SYSTEM
ROBERT BARKLEY, CHARLES HURST, ANDREW DUNHAM, JOANN SILVERSTEIN, and GAIL M. BRION (Colorado Univ., Boulder) Jul. 1992 9 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921362) Copyright

Iodine is being considered for disinfection of recycled hygiene and potable water in Space Station Freedom. Like chlorine, the halogen iodine can form disinfection by-products (DBPs) when used as a disinfectant in waters with dissolved or colloidal organic compounds. Recycled shower and laundry wastewater, urine, and condensate from the space cabin atmosphere all have large amounts of dissolved and colloidal organic compounds and may

generate iodinated DBPs which can be toxic to humans. We have investigated the formation of iodinated DBPs (IDP's) in model compounds typical of shower wastewater and condensate. The selection of these model compounds and flask experiments to test for IDP formation have been described. Methods for reaction, extraction, and analysis for IDPs also have been developed. We have tentatively identified likely organic precursors from recycled water and several iodinated organic compounds formed during the reaction with iodine. As we increase the complexity of the water matrix, eventually studying recycled shower wastewater, the flask experiment data will allow understanding of the reactions of iodine disinfectant with the organic compounds found in space water recycle systems. Author (revised)

A93-41534
SHIELDING STRATEGIES FOR HUMAN EXPLORATION MISSIONS
BENTON C. CLARK (Martin Marietta Planetary Sciences Lab., Denver, CO) Jul. 1992 8 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921376) Copyright

Space mission shielding strategies intended to protect aircraft crews from the galactic and solar flare radiation environments are reviewed. Particular attention is given to galactic cosmic ray hazards for Mars and lunar missions, and solar particle events during interplanetary Mars and moon flights. AIAA

A93-41539* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
ASDA - ADVANCED SUIT DESIGN ANALYZER COMPUTER PROGRAM
GRANT C. BUE, BRUCE C. CONGER, JOHN V. IOVINE (Lockheed Engineering & Sciences Co., Houston, TX), and CHI-MIN CHANG (NASA, Johnson Space Center, Houston, TX) Jul. 1992 12 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921381) Copyright

An ASDA model developed to evaluate the heat and mass transfer characteristics of advanced pressurized suit design concepts for low pressure or vacuum planetary applications is presented. The model is based on a generalized 3-layer suit that uses the Systems Integrated Numerical Differencing Analyzer '85 in conjunction with a 41-node FORTRAN routine. The latter simulates the transient heat transfer and respiratory processes of a human body in a suited environment. The user options for the suit encompass a liquid cooled garment, a removable jacket, a CO2/H2O permeable layer, and a phase change layer. AIAA

A93-41541
SPACE STATION CONDENSING HEAT EXCHANGER BIOFILM FORMATION AND CONTROL EVALUATION
ROBERT W. MARSH, NORMAN A. GRABOWSKI, and JOHN W. STEELE (Hamilton Standard, Windsor Locks, CT) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921383) Copyright

The Space Station Temperature and Humidity Control Condensing Heat Exchangers will be utilized to remove and collect atmospheric water vapor generated by the metabolic and hygienic activity of crew members. The porous hydrophilic coating within the heat exchangers will be continually moist and in contact with a steady flow of cabin air which makes them susceptible to microbial growth. This paper summarizes the findings from an ongoing study to evaluate biofilm formation characteristics and microbial control techniques for the Space Station Condensing Heat Exchangers (CHX). This ongoing study examines whether the CHX's are susceptible to performance degrading microbial colonization with microbial challenge testing under simulated system environmental conditions. Furthermore, the three candidate microbial control approaches of periodic heating, periodic drying, and incorporation of an antimicrobial agent, into the hydrophilic coating are evaluated. Author (revised)

A93-41542* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
FIRST ENTRY OPERATIONS FOR SPACECRAFT
STEVEN WILSON, THOMAS LIMERO (Krug Life Sciences, Inc., Houston, TX), and JOHN JAMES (NASA, Johnson Space Center, Houston, TX) Jul. 1992 9 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921384) Copyright

First entry procedures implemented in the industrial setting are considered to identify those applicable to the situation on the SSF. Particular attention is given to consequences when these procedures are not followed. Operational scenarios for nominal first entry procedures intended to verify air quality before the crew enters the module are outlined. Components of the Environmental Health System will provide necessary monitoring capability to protect crew health and safety during the planned first entry procedures of the man-tended capability phase of the SSF program. It is apparent that first-entry scenarios have drawn heavily upon industry experience, tempered with the specific characteristics of the space flight environment. AIAA

A93-41544* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
DEFINING CONTAMINATION CONTROL REQUIREMENTS FOR NON-HUMAN RESEARCH ON SPACE STATION FREEDOM
BARBARA J. CORBIN (NASA, Ames Research Center, Moffett Field, CA) and GLENN A. FUNK (GE Government Services, Moffett Field, CA) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921386) Copyright

The use of non-human biological specimens for life sciences research on Space Station Freedom has generated concerns about spacecraft internal contamination, crew safety and hardware utility. Various NASA organizations convened to discuss the concerns and determine how they should be addressed. This paper will present the issues raised at this meeting, the process by which safety concerns were identified, and the means by which contamination control requirements for all biological payloads were recommended for incorporation into Space Station Freedom safety requirements. The microbiological, toxicological and particulate contamination criteria for long-term spaceflight will be based on realistic assessment of risk and hardware will be designed to meet established contamination criteria while facilitating crew operations, thereby meeting the needs of the investigator. Author

A93-41545* National Aeronautics and Space Administration, Washington, DC.
POTENTIAL HEALTH EFFECTS OF FUME PARTICLES ON THE CREW OF SPACECRAFTS
JURAJ FERIN and GUNTER OBERDORSTER (Rochester Univ., NY) Jul. 1992 6 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(Contract NAGW-2356; NIH-ES-01247; NIH-ES-04872)
(SAE PAPER 921387) Copyright

The effect of the size of polymer (e.g., Teflon) particles in fumes inhaled by spacecraft personnel on the condition of the lung tissue and on the recovery of the exposed subjects was investigated in rats receiving a single intrapulmonary instillation, or repeated inhalation exposures to either TiO2 particles with primary particle diameter 20 nm, or TiO2 particles with primary particle diameter 250 nm. It was found that rats exposed to 20-nm-diam particles showed a dramatically higher toxicity and slower recovery compared to the group exposed to the 250-nm-diam particles, due to a larger extent of penetration of the interstitium of the lung by the finer particles. AIAA

A93-41547 National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
DESIGN AND EVALUATION OF A PAYLOAD TO SUPPORT PLANT GROWTH ONBOARD COMET 1

A. HOEHN (Colorado Univ., Boulder), M. H. KLISS (NASA, Ames Research Center, Moffett Field, CA), M. W. LUTTGES, M. C. ROBINSON, and L. S. STODIECK (Colorado Univ., Boulder) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(Contract NAGW-1197)
(SAE PAPER 921389) Copyright

The paper describes the design and the operation principles of the Plant Module for Autonomous Space Support (P-MASS), designed to provide life support for a variety of plants, algae, and bacteria in low earth orbit during the maiden flight of COMET-1, scheduled for 1993. During flight (scheduled to continue for 30 days), both color video images and collected environmental data (including light intensity, temperature, relative humidity, CO2 and O2 concentrations, soil moisture, and nutrients released) will be downlinked to earth several times a day. These data will also be stored within the payload and retrieved from it after reentry and recovery. AIAA

A93-41548
A MATRIX-BASED POROUS TUBE WATER AND NUTRIENT DELIVERY SYSTEM
R. C. MORROW, R. J. BULA, T. W. TIBBITTS, and W. R. DINAUER (Wisconsin Univ., Madison) Jul. 1992 7 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921390) Copyright

A system for providing nutrients and water to plants, while maintaining good aeration at the roots and preventing water from escaping in reduced gravity was developed on the basis of porous tubes embedded in a rooting matrix. Nutrient solution circulated through the porous tubes moves into the rooting matrix by capillary action. The system was successfully tested in short-term microgravity and will be flown aboard Space Shuttle. AIAA

A93-41549* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
REGENERATIVE LIFE SUPPORT SYSTEMS TEST BED PERFORMANCE - LETTUCE CROP CHARACTERIZATION
DANIEL J. BARTA, MARYBETH A. EDEEN (NASA, Johnson Space Center, Houston, TX), and BRADLEY D. ECKHARDT (Lockheed Engineering & Sciences Co., Houston, TX) Jul. 1992 9 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921391) Copyright

System performance in terms of human life support requirements was evaluated for two crops of lettuce (Lactuca sative cv. Waldmann's Green) grown in the Regenerative Life Support Systems Test Bed. Each crop, grown in separate pots under identical environmental and cultural conditions, was irrigated with half-strength Hoagland's nutrient solution, with the frequency of irrigation being increased as the crop aged over the 30-day crop tests. Averaging over both crop tests, the test bed met the requirements of 2.1 person-days of oxygen production, 2.4 person-days of CO2 removal, and 129 person-days of potential potable water production. Gains in the mass of water and O2 produced and CO2 removed could be achieved by optimizing environmental conditions to increase plant growth rate and by optimizing cultural management methods. AIAA

A93-41552* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THE GENERAL PURPOSE WORK STATION, A SPACIOUS MICROGRAVITY WORKBENCH
BONNIE P. DALTON, GREG K. SCHMIDT, and P. D. SAVAGE (NASA, Ames Research Center, Moffett Field, CA) Jul. 1992 11 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992
(SAE PAPER 921394) Copyright

The General Purpose Work Station (GPWS) is a laboratory multiuse facility, as demonstrated during the Spacelab Life Sciences 1 (SLS-1) flight. The unit provided particulate containment under varying conditions, served as an effective work space for manipulating live animals, e.g., rats, served as a containment facility for fixatives, and was proposed for use to conduct in-flight maintenance during connector pin repair. The cabinet has a front door large enough to allow installation of a full-size microscope in-flight and is outfitted with a side window to allow delivery of items into the cabinet without exposure to the spacelab atmosphere. Additional support subsystems include inside cabinet mounting, surgical glove fine manipulations capability, and ac or dc power supply for experiment equipment, as will be demonstrated during Spacelab J. The GPWS, integrated and maintained in a double flight-rack, interfaces to spacelab systems including water cooling, avionics and cabin air, and power. Verification has been completed for multiple spacelab scenarios including SLS-2, SL-J, and SLS-3. Author (revised)

A93-41553
DESIGN AND PRELIMINARY TESTING OF A MEMBRANE BASED WATER RECYCLING SYSTEM FOR EUROPEAN MANNED SPACE MISSIONS
J. M. BARREAU, T. BOUET (Carrar, France), P. AMBLARD, X. BOUISSON, C. GUIZARD, C. GAVACH, A. LARBOT, and R. A. BINOT (ESTEC, Noordwijk, Netherlands) Jul. 1992 10 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(Contract ESA-9254/90/NL/FG)
(SAE PAPER 921396) Copyright

Results are presented of a development work based on a study by Madsen et al. (1990) which identified a basic core technology system essentially based on membrane technologies and capable of providing recovery of water from moderately contaminated waste waters like hygiene water and condensation water. Attention is given to the detailed design of a breadboard of a core system consisting of three successive membrane units: ultrafiltration on a mineral membrane, reverse osmosis and electrodialysis, and an oxidation step. Experimental testing for the selection of individual components and for the definition of operating procedures have been performed. Feasibility demonstration tests on the complete core configuration are being performed using real shower water and condensation water from a cold room. Microbiologically, the stabilizing agent has a total bacteriocide effect, and no living microorganisms were detected in the stabilization tank after 24 hr in contact with 0.2 percent of oxonia. Checking was performed downstream, and confirms the absence of viable microorganisms in the other parts of the system. AIAA

A93-41554
EXPERIMENTAL AND THEORETICAL STUDY ON MEMBRANE DISTILLATION USING THERMOPERVAPORATION
NOBUO HAMANO, KENJI MITANI (Hitachi, Ltd., Space Systems Div., Yokohama, Japan), HIDEAKI KUROKAWA, TOSHIO SAWA (Hitachi, Ltd., Energy Research Lab., Japan), and AKIRA ASHIDA (Hitachi, Ltd., Space Systems Div., Tokyo, Japan) Jul. 1992 7 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921397) Copyright

Water recycling systems have been studied at Hitachi using thermopervaporation technology for space use for about 10 years. According to the studies this method is a good candidate for space application from the viewpoint of good water quality, system compactness and microgravity adaptability. In this paper we discuss (1) fundamental characteristics, (2) temperature distribution, and (3) effect of volatile substances of membrane distillation by the thermopervaporation method from both theoretical and experimental points of view. Author (revised)

A93-41555
HERMES ECLSS - MAIN REQUIREMENTS AND TECHNICAL SOLUTIONS
REINHARD SCHAEFER, STEPHEN LUCK, and GERHARD HAUSER (Dornier GmbH, Friedrichshafen, Germany) Jul. 1992 14 p. SAE, International Conference on Environmental Systems,

22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921400) Copyright

Some of the principal aspects of the development work carried out recently in the Hermes ECLSS are presented. For various constituent hardware items of the ECLSS, the technical constraints which are at the origin of the development work are described. The design concepts which have been identified and investigated to fulfill the constraints are discussed, and the technical solution which has been selected is presented. For some hardware items (e.g., cabin fan and toilet assembly), for which the initial design selection has been supported by breadboard tests, the rationale behind such tests and the major test results are presented.

AIAA

A93-41564* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SETTING SPACECRAFT MAXIMUM ALLOWABLE CONCENTRATIONS FOR 1 HOUR OR 24 HOUR CONTINGENCY EXPOSURES TO AIRBORNE CHEMICALS
HECTOR D. GARCIA, THOMAS F. LIMERO (Krug Life Sciences, Inc., Houston, TX), and JOHN T. JAMES (NASA, Johnson Space Center, Houston, TX) Jul. 1992 6 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921410) Copyright

Since the early years of the manned space program, NASA has developed and used exposure limits called Spacecraft Maximum Allowable Concentrations (SMACs) to help protect astronauts from airborne toxicants. Most of these SMACS are based on an exposure duration of 7 days, since this is the duration of a 'typical' mission. A set of 'contingency SMACs' is also being developed for scenarios involving brief (1-hour or 24- hour) exposures to relatively high levels of airborne toxicants from event-related 'contingency' releases of contaminants. The emergency nature of contingency exposures dictates the use of different criteria for setting exposure limits. The NASA JSC Toxicology Group recently began a program to document the rationales used to set new SMACs and plans to review the older, 7-day SMACs. In cooperation with the National Research Council's Committee on Toxicology, a standard procedure has been developed for researching, setting, and documenting SMAC values. Author (revised)

A93-41565* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
THE ROLE OF ENVIRONMENTAL HEALTH SYSTEM AIR QUALITY MONITORS IN SPACE STATION CONTINGENCY OPERATIONS
THOMAS F. LIMERO, STEVE WILSON, SUSAN PERLOT (Krug Life Sciences, Inc., Houston, TX), and JOHN JAMES (NASA, Johnson Space Center, Houston, TX) Jul. 1992 8 p. SAE, International Conference on Environmental Systems, 22nd, Seattle, WA, July 13-16, 1992 refs
(SAE PAPER 921414) Copyright

This paper describes the Space Station Freedom (SSF) Environmental Health System's air-quality monitoring strategy and instrumentation. A two-tier system has been developed, consisting of first-alert instruments that warn the crew of airborne contamination and a volatile organic analyzer that can identify volatile organic contaminants in near-real time. The strategy for air quality monitoring on SSF is designed to provide early detection so that the contamination can be confined to one module and so that crew health and safety can be protected throughout the contingency event. The use of air-quality monitors in fixed and portable modes will be presented as a means of following the progress of decontamination efforts and ensuring acceptable air quality in a module after an incident. The technology of each instrument will be reviewed briefly; the main focus of this paper, however, will be the use of air-quality monitors before, during, and after contingency incidents. Author (revised)

N93-27100*# Orbital Technologies Corp., Madison, WI.
1991 NASA LIFE SUPPORT SYSTEMS ANALYSIS WORKSHOP Final Report, 1991
PEGGY L. EVANICH (National Aeronautics and Space Administration, Washington, DC.), THOMAS M. CRABB, and CHARLES F. GARTRELL (General Research Corp., Vienna, VA.) 1 Mar. 1992 112 p Workshop held in Milwaukee, WI, 24-27 Jun. 1991
(Contract NASW-4470)
(NASA-CR-4466; NAS 1.26:4466) Avail: CASI HC A06/MF A02

The 1991 Life Support Systems Analysis Workshop was sponsored by NASA Headquarters' Office of Aeronautics and Space Technology (OAST) to foster communication among NASA, industrial, and academic specialists, and to integrate their inputs and disseminate information to them. The overall objective of systems analysis within the Life Support Technology Program of OAST is to identify, guide the development of, and verify designs which will increase the performance of the life support systems on component, subsystem, and system levels for future human space missions. The specific goals of this workshop were to report on the status of systems analysis capabilities, to integrate the chemical processing industry technologies, and to integrate recommendations for future technology developments related to systems analysis for life support systems. The workshop included technical presentations, discussions, and interactive planning, with time allocated for discussion of both technology status and time-phased technology development recommendations. Key personnel from NASA, industry, and academia delivered inputs and presentations on the status and priorities of current and future systems analysis methods and requirements. Author

N93-27101*# Orbital Technologies Corp., Madison, WI.
1992 NASA LIFE SUPPORT SYSTEMS ANALYSIS WORKSHOP Final Report, 1992
PEGGY L. EVANICH (National Aeronautics and Space Administration, Washington, DC.), THOMAS M. CRABB, and CHARLES F. GARTRELL (General Research Corp., Vienna, VA.) 1 Dec. 1992 84 p Workshop held in Houston, TX, 12-14 May 1992
(Contract NASW-4470)
(NASA-CR-4467; NAS 1.26:4467) Avail: CASI HC A05/MF A01

The 1992 Life Support Systems Analysis Workshop was sponsored by NASA's Office of Aeronautics and Space Technology (OAST) to integrate the inputs from, disseminate information to, and foster communication among NASA, industry, and academic specialists. The workshop continued discussion and definition of key issues identified in the 1991 workshop, including: (1) modeling and experimental validation; (2) definition of systems analysis evaluation criteria; (3) integration of modeling at multiple levels; and (4) assessment of process control modeling approaches. Through both the 1991 and 1992 workshops, NASA has continued to seek input from industry and university chemical process modeling and analysis experts, and to introduce and apply new systems analysis approaches to life support systems. The workshop included technical presentations, discussions, and interactive planning, with sufficient time allocated for discussion of both technology status and technology development recommendations. Key personnel currently involved with life support technology developments from NASA, industry, and academia provided input to the status and priorities of current and future systems analysis methods and requirements. Author

N93-27121# Federal Aviation Agency, Oklahoma City, OK. Civil Aeromedical Inst.
COMPARISON OF PORTABLE CREWMEMBER PROTECTIVE BREATHING EQUIPMENT (CPBE) DESIGNS Final Report
BRUCE WILCOX, JR., GARNET MCLEAN, and HARVEY ENGLAND, JR. Apr. 1993 11 p Sponsored by FAA Office of Aviation Medicine, Washington, DC
(DOT/FAA/AM-93/6) Avail: CASI HC A03/MF A01

Crewmemeber protective breathing equipment (CPBE) presently certified for transport category aircraft employ 3 types of oxygen production systems: chlorate candle, potassium

superoxide, and compressed oxygen. CPBE performance was evaluated to expose significant differences based on this distinction. CPBE tests employing humans were conducted in accordance with FAA Technical Standard Order C-116. All CPBE were tested for oxygen production, carbon dioxide concentration, internal temperature, moisture, and breathing resistance for 15 minutes at ground level (1,300 ft) and cabin altitude (8,000 ft), while subjects exercised. All CPBE produced a mean oxygen level of at least 59 percent and maintained carbon dioxide level below 5 percent at ground level. Differences in internal temperature and humidity were found. Performance at altitude generally paralleled these findings. Oxygen and carbon dioxide levels provide little discrimination about the relative merits of particular CPBE. However, differences in the wearability of CPBE, based on internal temperature, humidity, and weight, were dependent on the type of CPBE oxygen production system. Author

N93-27177 Technion - Israel Inst. of Tech., Haifa. Faculty of Aerospace Engineering.

VISUAL FIELD INFORMATION IN NAP-OF-THE-EARTH FLIGHT BY TELEOPERATED HELMET-MOUNTED DISPLAYS

ARTHUR J. GRUNWALD, S. KOHN, and S. J. MERHAV *In* Israel Society of Aeronautics and Astronautics, 32nd Annual Conference on Aviation and Astronautics p 78-97 20 Feb. 1992 Copyright Avail: Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel

The human ability to derive control-oriented visual field information from teleoperated helmet-mounted displays in nap-of-the-earth flight is investigated. The visual field with these types of display originates from a forward-looking infrared radiation camera, gimbal-mounted at the front of the aircraft and slaved to the pilot's line-of-sight, to obtain wide-angle coverage. Although these displays are proved to be effective in Apache and Cobra helicopter night operations, they demand very high pilot proficiency and work load. Experimental work presented in this paper has shown that part of the difficulties encountered in vehicular control by means of these displays can be attributed to the narrow viewing aperture and head/camera slaving system phase lags. Both of these shortcomings will impair visuo-vestibular coordination when voluntary head rotation is present. This might result in errors in estimating the control-oriented visual field information vital in vehicular control, such as the vehicle yaw rate or the anticipated flight path, or might even lead to visuo-vestibular conflicts (motion sickness). Since, under these conditions, the pilot will tend to minimize head rotation, the full wide-angle coverage of the helmet-mounted display, provided by the line-of-sight slaving system is not always fully utilized. ISA

N93-27718*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM

CHARLES RAY and ALAN ADAMS *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems p 317-341 1990

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on the Environmental Control and Life Support System (ECLSS) for the space station are presented. The ECLSS is divided into six subsystems: temperature and humidity control (THC), atmosphere control and supply (ACS), atmosphere revitalization (AR), fire detection and suppression (FDS), water recovery management (WRM), and waste management (WM). Topics covered include: ECLSS subsystem functions; ECLSS distributed system; ECLSS functional distribution; CO2 removal; CO2 reduction; oxygen generation; urine processor; and potable water recovery. CASI

N93-27719*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM EVOLUTION

PAUL WIELAND *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems p 343-365 1990

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on Environmental Control and Life Support System (ECLSS) evolution are presented. The Space Station Freedom ECLSS will have to accommodate the changes to Freedom as it evolves over the design life of 30 years or more. Requirements will change as pressurized modules are added, crew numbers increase, and as the tasks to be performed change. This evolution will result in different demands on the ECLSS and the numbers ECLSS will have to adapt. Technologies other than the baselined ones may be better able to perform the various tasks and technological advances will result in improved life support hardware having better performance, increased reliability, reduced power consumption, weight, and volume, greater autonomy, and fewer resupply requirements. A preliminary study was performed to look at alternative technologies for life support and evaluate them for their integration requirements. Derived from text

N93-27720*# McDonnell-Douglas Space Systems Co., Huntsville, AL.

TECHNOLOGIES FOR ECLSS EVOLUTION

BRYCE L. DIAMANT *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems p 367-493 1990

(Contract NAS8-36407)

Avail: CASI HC A05/MF A04; 1 functional color page

Viewgraphs and discussion on technologies for Environmental Control and Life Support System (ECLSS) evolution are presented. Topics covered include: atmosphere revitalization including CO2 removal, CO2 reduction, O2 generation, and trace contaminant control; water recovery and management including urine processing, hygiene water processing, and potable water processing; and waste management. ECLSS technology schematics, process diagrams, and fluid interfaces are included. CASI

N93-27721*# Texas A&M Univ., College Station. Space Research Center.

ALTERNATIVE PROCESSES FOR WATER RECLAMATION AND SOLID WASTE PROCESSING IN A PHYSICAL/CHEMICAL BIOREGENERATIVE LIFE SUPPORT SYSTEM

TOM D. ROGERS *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems p 495-515 1990

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on alternative processes for water reclamation and solid waste processing in a physical/chemical-bioregenerative life support system are presented. The main objective is to focus attention on emerging influences of secondary factors (i.e., waste composition, type and level of chemical contaminants, and effects of microorganisms, primarily bacteria) and to constructively address these issues by discussing approaches which attack them in a direct manner. Derived from text

N93-27722*# Wyle Labs., Inc., Huntsville, AL.

INCREASED FIRE AND TOXIC CONTAMINANT DETECTION RESPONSIBILITY BY USE OF DISTRIBUTED, ASPIRATING SENSORS

WALLACE W. YOUNGBLOOD *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems p 517-541 1990

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs of increased fire and toxic contaminant detection responsivity by use of distributed, aspirating sensors for space station are presented. Objectives of the concept described are (1) to enhance fire and toxic contaminant detection responsivity in habitable regions of space station; (2) to reduce system weight

and complexity through centralized detector/monitor systems; (3) to increase fire signature information from selected locations in a space station module; and (4) to reduce false alarms.

Derived from text

N93-27723*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

THE ECLSS ADVANCED AUTOMATION PROJECT EVOLUTION AND TECHNOLOGY ASSESSMENT

BRANDON S. DEWBERRY, JAMES R. CARNES (Boeing Co., Huntsville, AL.), BRENDA D. LUKEFAHR (Alabama Univ., Huntsville.), JOHN S. ROGERS (Alabama Univ., Huntsville.), DANIEL M. ROCHOWIAK (Alabama Univ., Huntsville.), JAMES W. MCKEE (Alabama Univ., Huntsville.), and BRIAN L. BENSON (Alabama Univ., Huntsville.) *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems p 543-565 1990

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on Environmental Control and Life Support System (ECLSS) advanced automation project evolution and technology assessment are presented. Topics covered include: the ECLSS advanced automation project; automatic fault diagnosis of ECLSS subsystems descriptions; in-line, real-time chemical and microbial fluid analysis; and object-oriented, distributed chemical and microbial modeling of regenerative environmental control systems description. CASI

N93-27724*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

MARSHALL SPACE FLIGHT CENTER ECLSS TECHNOLOGY ACTIVITIES

PAUL WIELAND *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems p 567-598 1990

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on Environmental Control and Life Support System (ECLSS) technology activities are presented. Topics covered include: analytical development; ECLSS modeling approach; example of water reclamation modeling needs; and hardware development and testing. CASI

N93-27725*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

JSC ECLSS R/T PROGRAM OVERVIEW

A. F. BEHREND *In* NASA, Washington, Technology for Space Station Evolution. Volume 2: Data Management System/Environmental Control and Life Support Systems p 599-619 1990

Avail: CASI HC A03/MF A04; 1 functional color page

Viewgraphs on Johnson Space Center Environmental Control and Life Support System (ECLSS) research and technology program overview are presented. Topics covered include: advancements in electrochemical CO2 removal; supercritical water waste oxidation; electrooxidation for post-treatment of reclaimed water; and photocatalytic post-treatment of reclaimed water. CASI

N93-27787*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

EXTRAVEHICULAR ACTIVITY SYSTEM

MICHAEL N. ROUEN *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System p 5-31 1990

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs and discussion on the extravehicular activity system for space station evolution are presented. The following topics are addressed: (1) EVAS program status; (2) definition of EVAS baseline; (3) baseline functional requirements; (4) definition of evolutionary EVAS; (5) evolutionary EVAS functional requirements; and (6) technology status. CASI

N93-27788*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

MAN-SYSTEMS DISTRIBUTED SYSTEM FOR SPACE STATION FREEDOM

J. L. LEWIS *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System p 33-56 1990

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on man-systems distributed system for Space Station Freedom are presented. Topics addressed include: description of man-systems (definition, requirements, scope, subsystems, and topologies); implementation (approach, tools); man-systems interfaces (system to element and system to system); prime/supporting development relationship; selected accomplishments; and technical challenges. CASI

N93-27789*# National Aeronautics and Space Administration, Washington, DC.

EVA/MANNED SYSTEMS

JAMES P. JENKINS *In its* Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System p 59-68 1990

Avail: CASI HC A02/MF A03; 1 functional color page

Viewgraphs on extravehicular activity/manned systems are presented. Objectives of crewstation design include (1) development of human-computer interface technology and graphical presentations, including multi-dimensional visual and aural displays; (2) provide a technology base for autonomous vision and other perceptual systems, virtual workstation technology, and computational vision systems; and (3) develop databases and models of human strength, motion, and body positions in microgravity environments. Extravehicular technology is addressed. CASI

N93-27790*# Hamilton Standard, Windsor Locks, CT. Space and Sea Systems.

EVOLUTION OF SPACE STATION EMU PLSS TECHNOLOGY RECOMMENDATIONS

RICHARD C. WILDE *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System p 69-111 1990

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on extravehicular mobility unit (EMU) portable life support system (PLSS) technology recommendations are presented. Topics covered include: oxygen supply storage; oxygen supply regulators; carbon dioxide control; prime movers; crew comfort; heat rejection; power sources; controls; display devices; and sensor technology. CASI

N93-27791*# McDonnell-Douglas Space Systems Co., Huntington Beach, CA.

EVOLVING EVA SYSTEM CAPABILITY FOR THE EVOLVING SPACE STATION FREEDOM REQUIREMENTS

HOWARD SLADE *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System p 113-119 1990

Avail: CASI HC A02/MF A03; 1 functional color page

Viewgraphs on evolving extravehicular activity (EVA) system capability for the evolving Space Station Freedom requirements are presented. Topics covered include: pre-scrub 1989 baseline; approach shift resulting from scrub 1989; considerations for alternative selection; EVA supply options; and key technologies for evolution of EVA system life support. CASI

N93-27792*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EVA AND TELEROBOT INTERACTION

KELLI F. WILLSHIRE *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System p 121-139 1990

Avail: CASI HC A03/MF A03; 1 functional color page

We are about to enter into a new era - that of astronauts working hand in hand with telerobots in space. This has been

done to some degree with astronauts and the Space Station Shuttle's Remote Manipulator Arm. However, for the Space Station Freedom, not only will astronauts be working with the RMS type system but also with smaller, more dexterous systems such as the Flight Telerobotic Servicer (FTS). Because EVA time is a premium resource, the most effective use of the astronauts and the telerobot will be required. There may be some tasks for which it is most efficient to have both the EVA astronaut and the telerobot working together. This type of close integration has not occurred before and brings up many issues. Most of these issues are related to technology: communication must be infallible, new control systems and devices may be required, enhanced telerobot safety systems may be necessary. IVA operations may also be affected by the combined EVA telerobot tasks. There is also the issue of how the EVA astronaut and the telerobot work on separate tasks but at the same time. For both situations, research and development of at least some new technology is required; enhanced communication both by voice and data, sophisticated collision detection systems, more responsive controls and displays. These new systems or system enhancements may require knowledge base systems for their operation. Some of the important issues, types of tasks, the FTS capabilities, the technology that is needed to address those issues, and the possible impact on Space Station Freedom are reviewed. Author (revised)

N93-27793*# Lockheed Missiles and Space Co., Sunnyvale, CA. Astronautics Div.

SIMPLIFIED AID FOR CREW RESCUE (SAFR)

H. THOMAS FISHER *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System p 141-163 1990

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs and discussion of a Crew Emergency Rescue System (CERS) are presented. Topics covered include: functional description; operational description; interfaces with other subsystems/elements; simplified aid for crew rescue (SACR) characteristics; potential resource requirements; logistics, repair, and resupply; potential performance improvements; and automation impact. CASI

N93-27794*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

EVOLVING TECHNOLOGIES FOR SPACE STATION FREEDOM COMPUTER-BASED WORKSTATIONS

DEAN G. JENSEN and MARIANNE RUDISILL *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System p 165-179 1990

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on evolving technologies for Space Station Freedom computer-based workstations are presented. The human-computer computer software environment modules are described. The following topics are addressed: command and control workstation concept; cupola workstation concept; Japanese experiment module RMS workstation concept; remote devices controlled from workstations; orbital maneuvering vehicle free flyer; remote manipulator system; Japanese experiment module exposed facility; Japanese experiment module small fine arm; flight telerobotic servicer; human-computer interaction; and workstation/robotics related activities. CASI

N93-27795*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.

MAN-SYSTEMS INTEGRATION AND THE MAN-MACHINE INTERFACE

JOSEPH P. HALE *In* NASA, Washington, Technology for Space Station Evolution. Volume 3: EVA/Manned Systems/Fluid Management System p 181-192 1990

Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on man-systems integration and the man-machine interface are presented. Man-systems integration applies the systems' approach to the integration of the user and the machine to form an effective, symbiotic Man-Machine System (MMS). A MMS is a combination of one or more human beings and one or more physical components that are integrated through the common purpose of achieving some objective. The human operator interacts with the system through the Man-Machine Interface (MMI). CASI

N93-27847*# Vanderbilt Univ., Nashville, TN.

EVA GLOVE RESEARCH TEAM Annual Report

ALVIN M. STRAUSS, STEVEN W. PETERSON, JOHN A. MAIN, RUEBEN D. DICKENSON, BOBBY L. SHIELDS, and CHRISTINE H. LORENZ (Vanderbilt Univ. Hospital, Nashville, TN.) Jul. 1992 83 p

(Contract NAGW-2546)

(NASA-CR-193014; NAS 1.26:193014) Avail: CASI HC A05/MF A01

The goal of the basic research portion of the extravehicular activity (EVA) glove research program is to gain a greater understanding of the kinematics of the hand, the characteristics of the pressurized EVA glove, and the interaction of the two. Examination of the literature showed that there existed no acceptable, non-invasive method of obtaining accurate biomechanical data on the hand. For this reason a project was initiated to develop magnetic resonance imaging as a tool for biomechanical data acquisition and visualization. Literature reviews also revealed a lack of practical modeling methods for fabric structures, so a basic science research program was also initiated in this area.

N93-27848*# Vanderbilt Univ., Nashville, TN.

A FEASIBILITY STUDY OF HAND KINEMATICS FOR EVA ANALYSIS USING MAGNETIC RESONANCE IMAGING

RUEBEN D. DICKENSON, CHRISTINE H. LORENZ (Vanderbilt Univ. Hospital, Nashville, TN.), STEVEN W. PETERSON, ALVIN M. STRAUSS, and JOHN A. MAIN *In its* EVA Glove Research Team 11 p Jul. 1992 Presented at the 22nd International Conference on Environmental Systems, Seattle, WA, 13-16 Jul. 1992

Avail: CASI HC A03/MF A01

A new method of analyzing the kinematics of joint motion is developed. Magnetic Resonance Imaging (MRI) offers several distinct advantages. Past methods of studying anatomic joint motion have usually centered on four approaches. These methods are x-ray projection, goniometric linkage analysis, sonic digitization, and landmark measurement of photogrammetry. Of these four, only x-ray is applicable for in vivo studies. The remaining three methods utilize other types of projections of inter-joint measurements, which can cause various types of error. MRI offers accuracy in measurement due to its tomographic nature (as opposed to projection) without the problems associated with x-ray dosage. Once the data acquisition of MR images was complete, the images were processed using a 3D volume rendering workstation. The metacarpalphalangeal (MCP) joint of the left index finger was selected and reconstructed into a three-dimensional graphic display. From the reconstructed volumetric images, measurements of the angles of movement of the applicable bones were obtained and processed by analyzing the screw motion of the MCP joint. Landmark positions were chosen at distinctive locations of the joint at fixed image threshold intensity levels to ensure repeatability. The primarily two dimensional planar motion of this joint was then studied using a method of constructing coordinate systems using three (or more) points. A transformation matrix based on a world coordinate system described the location and orientation of a local target coordinate system. Future research involving volume rendering of MRI data focusing on the internal kinematics of the hand's individual ligaments, cartilage, tendons, etc. will follow. Its findings will show the applicability of MRI to joint kinematics for gaining further knowledge of the hand-glove (power assisted) design for extravehicular activity (EVA).

Derived from text

N93-27849*# Vanderbilt Univ., Nashville, TN.

A PRELIMINARY STRUCTURAL ANALYSIS OF SPACE-BASED INFLATABLE TUBULAR FRAME STRUCTURES

JOHN A. MAIN, STEVEN W. PETERSON, and ALVIN M. STRAUSS *In its* EVA Glove Research Team 7 p Jul. 1992
Avail: CASI HC A02/MF A01

The use of inflatable structures has often been proposed for aerospace and planetary applications. The advantages of such structures include low launch weight and easy assembly. The use of inflatables for applications requiring very large frame structures intended for aerospace use are proposed. In order to consider using an inflated truss, the structural behavior of the inflated frame must be examined. The statics of inflated tubes as beams was discussed in the literature, but the dynamics of these elements has not received much attention. In an effort to evaluate the vibration characteristics of the inflated beam a series of free vibration tests of an inflated fabric cantilevers were performed. Results of the tests are presented and models for system behavior posed. Author (revised)

N93-27850*# Vanderbilt Univ., Nashville, TN.
POWER ASSIST EVA GLOVE DEVELOPMENT
JOHN A. MAIN, STEVEN W. PETERSON, and ALVIN M. STRAUSS *In its* EVA Glove Research Team 17 p Jul. 1992
Presented at the 22nd International Conference on Environmental Systems, Seattle, WA, 13-16 Jul. 1992
Avail: CASI HC A03/MF A01

Structural modeling of the EVA glove indicates that flexibility in the metacarpophalangeal (MCP) joint can be improved by selectively lowering the elasticity of the glove fabric. Two strategies are used to accomplish this. One method uses coil springs on the back of the glove to carry the tension in the glove skin due to pressurization. These springs carry the loads normally borne by the glove fabric, but are more easily deformed. An active system was also designed for the same purpose and uses gas filled bladders attached to the back of the EVA glove that change the dimensions of the back of the glove and allow the glove to bend at the MCP joint, thus providing greater flexibility at this joint. A threshold control scheme was devised to control the action of the joint actuators. Input to the controller was provided by thin resistive pressure sensors placed between the hand and the pressurized glove. The pressure sensors consist of a layer of polyester film that has a thin layer of ink screened on the surface. The resistivity of the ink is pressure dependent, so an extremely thin pressure sensor can be fabricated by covering the ink patch with another layer of polyester film and measuring the changing resistance of the ink with a bridge circuit. In order to sense the force between the hand and the glove at the MCP joint, a sensor was placed on the palmar face of the middle finger. The resultant signal was used by the controller to decide whether to fill or exhaust the bladder actuators on the back of the glove. The information from the sensor can also be used to evaluate the effectiveness of a given control scheme or glove design since the magnitude of the measured pressures gives some idea of the torque required to bend a glove finger at the MCP joint. Tests of this actuator, sensor, and control system were conducted in an 57.2 kPa glove box by performing a series of 90 degree finger bends with a glove without an MCP joint assembly, a glove with the coil spring assembly, and with the four fingered actuated glove. The tests of these three glove designs confirm the validity of the model. Author

N93-27851# Hilton Systems, Inc., Cherry Hill, NJ.
AGE 60 PROJECT: CONSOLIDATED DATABASE EXPERIMENTS Final Report
EDWIN J. KAY (Lehigh Univ., Bethlehem, PA.), REGINA M. HARRIS, ROBERT S. VOROS (Lehigh Univ., Bethlehem, PA.), DONALD J. HILLMAN (Lehigh Univ., Bethlehem, PA.), DIANE T. HYLAND (Lehigh Univ., Bethlehem, PA.), and JAMES D. DEIMLER Mar. 1993 96 p
(Contract DTFA02-90-90125)
(HS-TR-8025-3C(R2)) Avail: CASI HC A05/MF A01

Statistical analysis on historical data was conducted to investigate the relationship between pilot age and accident rates. The ultimate long-term aim of the Age 60 Project was to enhance aviation safety by increasing understanding about the relationships among pilot age, experience, and accident rates. The specific aims of the project were: to consolidate the currently separate databases related to pilot certification and aviation accidents and incidents; and to use this consolidated database to statistically examine the relationships that exist among chronological age, accidents, and other factors. Although the study was primarily directed at pilots who fly for FAR Part 121 air carriers who are subject to the Age 60 Rule, additional analyses were conducted for other categories of pilots to take advantage of additional data available for active pilots beyond the age of 60, and to further examine the influence of confounding factors. Derived from text

N93-27858*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEMS
CHARLES D. RAY *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview p 85-101 1990
Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on Environmental Control and Life Support Systems (ECLSS) for Space Station Freedom are presented. Topics covered include: crew generated wastes processing and reclamation; water reclamation - pre- and post-treatment; simplified waste water processing; improved trace contaminant removal; and real time microbial analysis. CASI

N93-27859*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EXTRAVEHICULAR ACTIVITY TECHNOLOGY DISCIPLINE
BRUCE W. WEBBON *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview p 103-117 1990
Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on extravehicular activity technology discipline for Space Station Freedom are presented. Topics covered include: extravehicular mobility unit; airlock and EMU support equipment; tools, mobility aids, and workstations; and telerobotic work aids interfaces. CASI

N93-27860*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MANNED SYSTEMS TECHNOLOGY DISCIPLINE
REMUS BRETOI *In* NASA, Washington, Technology for Space Station Evolution. Executive Summary and Overview p 119-140 1990
Avail: CASI HC A03/MF A03; 1 functional color page

Viewgraphs on manned systems technology discipline for Space Station Freedom are presented. Topics covered include: crew-systems interfaces and interactions; crew training; on-board systems maintenance and support; habitability and environment; and computational human factors. CASI

N93-27927# Search Technology, Inc., Norcross, GA.
SPECIFICATION OF ADAPTIVE AIDING SYSTEMS Final Report, 30 Mar. - 30 Nov. 1990
ROBERT C. ANDES, JR. and WILLIAM B. ROUSE Jul. 1992 72 p
(Contract F33615-88-C-3612)
(AD-A263071; STI-TR-8925-001; NAWCADWAR-92086-60)
Avail: CASI HC A04/MF A01

Designers' decision making in specifying adaptive aiding systems is considered. A study of design decisions in specifying aiding for a fighter aircraft mission scenarios is discussed. The requisite background knowledge required for the design of aiding systems and inherent complexity of situations to which adaptive aiding is applicable is quite broad. Considering these facts, the initial analysis of aiding designer's decision processes focused on identification and validation of solutions currently used in the design process. Results indicate a high degree of consistency on the part of individual designers. However, there were substantial variations among designers in terms of both decisions made and information used to make the decisions. The implications of these results for development of design tools, as well as the types of

research studies whose results would be valued by designers, are considered. DTIC

N93-27967*# Bechtel National, Inc., San Francisco, CA.
OXYGEN PRODUCTION ON THE LUNAR MATERIALS PROCESSING FRONTIER
BARBARA H. ALTENBERG *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium 14 p Feb. 1992
Avail: CASI HC A03/MF A03

During the pre-conceptual design phase of an initial lunar oxygen processing facility, it is essential to identify and compare the available processes and evaluate them in order to ensure the success of such an endeavor. The focus of this paper is to provide an overview of materials processing to produce lunar oxygen as one part of a given scenario of a developing lunar occupation. More than twenty-five techniques to produce oxygen from lunar materials have been identified. While it is important to continue research on any feasible method, not all methods can be implemented at the initial lunar facility. Hence, it is necessary during the pre-conceptual design phase to evaluate all methods and determine the leading processes for initial focus. Researchers have developed techniques for evaluating the numerous proposed methods in order to suggest which processes would be best to go to the Moon first. As one section in this paper, the recent evaluation procedures that have been presented in the literature are compared and contrasted. In general, the production methods for lunar oxygen fall into four categories: thermochemical, reactive solvent, pyrolytic, and electrochemical. Examples from two of the four categories are described, operating characteristics are contrasted, and terrestrial analogs are presented when possible. In addition to producing oxygen for use as a propellant and for life support, valuable co-products can be derived from some of the processes. This information is also highlighted in the description of a given process. Author (revised)

N93-27976*# Arizona Univ., Tucson. Environmental Research Lab.
CLOSED ECOLOGICAL SYSTEMS: FROM TEST TUBES TO EARTH'S BIOSPHERE
ROBERT J. FRYE and GEORGE MIGNON *In its* Proceedings of the Lunar Materials Technology Symposium 19 p Feb. 1992
Avail: CASI HC A03/MF A03

Artificially constructed closed ecological systems (CES) have been researched both experimentally and theoretically for over 25 years. The size of these systems have varied from less than one liter to many thousands of cubic meters in volume. The diversity of the included components has a similarly wide range from purely aquatic systems to soil based systems that incorporate many aspects of Earth's biosphere. While much has been learned about the functioning of these closed systems, much remains to be learned. In this paper, we compare and contrast the behavior of closed ecological systems of widely different sizes through an analysis of their atmospheric composition. In addition, we will compare the performance of relatively small CES with the behavior of Earth's biosphere. We address the applicability of small CES as replicable analogs for planetary biospheres and discuss the use of small CES as an experimental milieu for an examination of the evolution of extra-terrestrial colonies. Author (revised)

N93-27977*# United Technologies Corp., Farmington, CT. Hamilton Standard Div.
SPE WATER ELECTROLYZERS IN SUPPORT OF THE LUNAR OUTPOST
J. F. MCELROY *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium 20 p Feb. 1992
Avail: CASI HC A03/MF A03

During the 1970s, the SPE water electrolyzer, which uses ion exchange membranes as its sole electrolyte, was developed for nuclear submarine metabolic oxygen production. These developments included SPE water electrolyzer operation at up to 3,000 psia and at current densities in excess of 1,000 amps per square foot. The SPE water electrolyzer system is now fully qualified for both the U.S. and U.K. Navies with tens of thousands of system hours accumulated at sea. During the 1980s, the basic SPE water electrolyzer cell structure developed for the Navies was incorporated into several demonstrations for NASA's Space Station Program. Among these were: the SPE regenerative fuel cell for electrical energy storage; the SPE water electrolyzer for metabolic oxygen production; and the high pressure SPE water electrolyzer for reboost propulsion reactant production. In the 1990s, one emphasis will be the development of SPE water electrolyzers for the Lunar Outposts Currently defined potential Lunar Outpost applications for the SPE water electrolyzer include: SPE water electrolyzers for metabolic oxygen and potable water production from reclaimed water; and SPE water electrolyzers operating at high pressure as part of stationary and mobile surface energy storage systems. Author (revised)

N93-27978*# Lockheed Engineering and Sciences Co., Houston, TX. Life Support Development Lab.
ASSESSMENT OF THE STATE OF THE ART IN LIFE SUPPORT ENVIRONMENTAL CONTROL FOR SEI
CHARLES H. SIMONDS and GARY P. NOYES *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium 14 p Feb. 1992
Avail: CASI HC A03/MF A03

This paper defines the types of technology that would be used in a lunar base for environmental control and life support system and how it might relate to in situ materials utilization (ISMU) for the Space Exploration Initiative (SEI). There are three types of interaction between ISMU and the Environmental Control and Life Support System (ECLSS): (1) ISMU can reduce cost of water, oxygen, and possibly diluent gasses provided to ECLSS--a corollary to this fact is that the availability of indigenous resources can dramatically alter life support technology trade studies; (2) ISMU can use ECLSS waste systems as a source of reductant carbon and hydrogen; and (3) ECLSS and ISMU, as two chemical processing technologies used in spacecraft, can share technology, thereby increasing the impact of technology investments in either area. Author (revised)

N93-27979*# AiResearch Mfg. Co., Los Angeles, CA.
DUST PROTECTION FOR ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEMS IN THE LUNAR ENVIRONMENT
SUSAN FUHS and JEFFREY HARRIS (Lockheed Corp., Houston, TX.) *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium 12 p Feb. 1992
Avail: CASI HC A03/MF A03

Lunar dust is pervasive, and requirements for dust protection will affect both hardware design and operations planning for lunar surface systems. On Earth, mechanical problems caused by particulates include erosive and abrasive effects, clogging of mechanical equipment, and impairment of seals and bonds. In addition, dust tends to degrade the heat rejection properties of contaminated surfaces. All these effects have been observed on the lunar surface as well. This paper discusses the potential applicability of current dust protection methods to the problem of dust protection for the environmental control and life support (ECLS) systems of a lunar base, and highlights areas where development may be necessary. A review of dust problems experienced during the Apollo missions and of additional, ground-based experience with lunar dust provides a baseline for identifying operations and areas where dust may be expected to affect the ECLS systems. Current Earth-based methods of dust protection are identified and the impact of differences between the Earth and lunar environments on these methods is evaluated. Finally, integration of dust protection equipment with ECLS systems equipment is discussed. Author (revised)

N93-27985*# Boeing Defense and Space Group, Huntsville, AL.
LUNAR BASE THERMAL MANAGEMENT/POWER SYSTEM ANALYSIS AND DESIGN
JERRY R. MCGHEE *In* Arizona Univ., Proceedings of the Lunar Materials Technology Symposium 12 p Feb. 1992
Avail: CASI HC A03/MF A03

A compilation of several lunar surface thermal management

and power system studies completed under contract and IR&D is presented. The work includes analysis and preliminary design of all major components of an integrated thermal management system, including loads determination, active internal acquisition and transport equipment, external transport systems (active and passive), passive insulation, solar shielding, and a range of lunar surface radiator concepts. Several computer codes were utilized in support of this study, including RADSIM to calculate radiation exchange factors and view factors, RADIATOR (developed in-house) for heat rejection system sizing and performance analysis over a lunar day, SURPWER for power system sizing, and CRYSTORE for cryogenic system performance predictions. Although much of the work was performed in support of lunar rover studies, any or all of the results can be applied to a range of surface applications. Output data include thermal loads summaries, subsystem performance data, mass, and volume estimates (where applicable), integrated and worst-case lunar day radiator size/mass and effective sink temperatures for several concepts (shielded and unshielded), and external transport system performance estimates for both single and two-phase (heat pumped) transport loops. Several advanced radiator concepts are presented, along with brief assessments of possible system benefits and potential drawbacks. System point designs are presented for several cases, executed in support of the contract and IR&D studies, although the parametric nature of the analysis is stressed to illustrate applicability of the analysis procedure to a wide variety of lunar surface systems. The reference configuration(s) derived from the various studies will be presented along with supporting criteria. A preliminary design will also be presented for the reference basing scenario, including qualitative data regarding TPS concerns and issues. Author (revised)

N93-28029# National Space Development Agency, Tokyo (Japan).
CONCEPTUAL STUDY ON MANNED LUNAR SURFACE SITE [YUUJIN GETSUMEN KYOTEN NO GAINEN KENTOU]
YUTAKA TAKANO *In its* Future Space Activity Workshop: Lunar Base Workshop 1992 17 p 15 Jul. 1992 In JAPANESE
Avail: CASI HC A03/MF A06

An overview of the conceptual study of a manned lunar surface site, a small scale activity site for a small number of crew members is presented. The objectives of the manned lunar surface site are as follows: (1) validating that human beings can conduct multiple activities on the lunar surface; (2) validating the feasibility of outstanding development of scientific experiment and technology by human activities on the lunar surface; (3) validating the feasibility of providing materials for space activity and further developing production activities in space; (4) greatly promoting scientific knowledge about astronomy and space science by astronomical and space science observation on the lunar surface; and (5) allowing a wide range of people to understand the prospects of space development. The design concept and missions of the manned lunar base are outlined. The system and its subsystems, such as structure and mechanism, habitation, electric power, thermal control, communication, control, logistics, flight and landing subsystems are outlined. The construction and operation plans are presented. Author (NASDA)

N93-28031# Nippon Electric Co. Ltd., Tokyo (Japan).
CONCEPTUAL STUDY OF MANNED LUNAR SURFACE SITE [YUUJIN GETSUMEN KYOTEN NO GAINEN KENTOU]
TOSHIAKI OKUDAIRA, HARUKI AYATA, KIYOSHI TANAKA, NOBUTAKA KATOU, and NAOKI YOSHIZAWA *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 22 p 15 Jul. 1992 In JAPANESE
Avail: CASI HC A03/MF A06

An overview of a study of a lunar surface site system which does not necessitate Extravehicular Activity (EVA) and robotic support in starting the site is presented. Functional and performance requirements for the system, system configurations, system structure, weight and electric power allotments, and subsystems (such as structures, habitat, electric power, thermal control, communication control experiment, logistics, and flight and landing subsystems) were studied. Interface requirements with other systems, such as ground test equipment, launch vehicle, earth orbit assembly facility, ground control station, manned lunar landing and take-off vehicle, and lunar freight transport vehicle were also studied. Construction methods, such as operations robots, construction procedures, and leveling mechanism after landing are outlined. The results of the study of operation and maintenance methods and system analysis are introduced. The functional requirements, system concept, operation methods, including remote control, automation, automation, and development and operation plan for robots are outlined. Author (NASDA)

N93-28032# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
MANNED LUNAR SURFACE SITE: CONCEPTUAL STUDY ON PRESSURIZED LUNAR SURFACE OPERATION ROVER [YUUJIN GETSUMEN KYOTEN: YOATSUGATA GETSUMEN SAGYOU ROBA NO GAINEN KENTOU]
YOUICHIROU NAKAMURA, KEIKO YASUDA, ISAO TATE, MASAHARU TAKADA, SHUUJI TAKAHASHI, and MICHIHIKO HORIE *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 21 p 15 Jul. 1992 In JAPANESE
Avail: CASI HC A03/MF A06

An overview of the conceptual study on pressurized manned lunar rover to enable the safety operation of exploration crew is presented. Subjects of the operation of the rover were studied to determine its function and property requirements. Operation modes, including mission operation mode and system maintenance mode, and operation profiles, including those for initial assembly and manned missions, were studied to determine requirements from the operational aspects. The system and subsystem structures, including resource distribution and control methods, to meet the function and property requirements were studied. Two types of configurations of the Remote Manipulator Systems (RMS's) were determined. Author (NASDA)

N93-28033# Kawasaki Heavy Industries Ltd., Kobe (Japan).
MANNED LUNAR SURFACE SITE [YUUJIN GETSUMEN KYOTEN]
TERUMITSU KAMATA and HIROYUKI TORII *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 17 p 15 Jul. 1992 In JAPANESE
Avail: CASI HC A03/MF A06

Functions required for environment control system (mainly on air conditioning and air regeneration equipment) for the purpose of calculating their weight and electric power requirement for habitation module of manned lunar surface site were studied. Studies were conducted on subsystem performance requirements to satisfy the required functions and comparison of constituent equipment for the environment control system were conducted to select candidate equipment. Required electric power and weight were calculated and totaled to figure out the weight and electric power requirement of the environment control system. The above studies were conducted on air circulation, temperature and humidity control, and particles and microorganisms removal of air conditioning equipment and CO2 removal and toxic gas processing equipment for air regeneration. Author (NASDA)

N93-28034# Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo (Japan).
LUNAR SURFACE EXPERIMENT SYSTEM [GETSUMEN JIKKEN SHISUTEMU]
MASAKAZU TAKAMI, SEIKO HOSHI, and YURIKO OKA *In* NASDA, Future Space Activity Workshop: Lunar Base Workshop 1992 22 p 15 Jul. 1992 In JAPANESE
Avail: CASI HC A03/MF A06

An overview of the study on experiment systems operated at manned lunar surface site is presented. Missions to be conducted at manned lunar surface site were selected by evaluating from the view points of required resources (electric power, weight, and crew man hours), feasibility, operability, and especially significance as the frontier base. Mission performance sites, such as pressurized and exposed (located near habitation module or at remote location)

environments, and system structures, including their ingredient subsystems, corresponding to them are outlined. Resource allotment for the experiment system from the lunar surface site, resources required for the missions, and mission crew time for the experiment system were analyzed and the crew time required for experiment operations at manned lunar base was determined. Approximate time required for conducting each mission was studied. A model mission operation and an example of lunar surface experiment system operation (for pressurized environment and near module experiments) are shown. Author (NASDA)

N93-28112# Mainstream Engineering Corp., Rockledge, FL.
LIGHTWEIGHT PASSIVE MICROCLIMATE COOLING DEVICE Final Report, Aug. 1991 - Mar. 1992
CLYDE F. PARRISH and ROBERT P. SCARINGE Mar. 1993 65 p
(AD-A262262; NATICK-TR-93/014) Avail: CASI HC A04/MF A01

The intermittent adsorption cooling concept has been successfully demonstrated and has produced cooling rates in the 300 W range. The design requirement of 300 W for 6 hours has not been demonstrated due to system leaks. However, we demonstrated in laboratory experiments that were scaled to a much smaller size that we have produced 325 to 432 V of cooling. Laboratory experiments also showed the system could operate for more than 8 hours, be started and stopped, when the system contained no leaks. The current prototype was constructed of brass and copper for ease of fabrication. No consideration was given to weight. We have examined alternate methods of construction of the backpack and cylinder assembly and thin (0.01 in.) stainless steel could be used. The stainless steel sheet stock could be formed into a backpack bedding the sheets into fins, which also serve to strengthen the backpack. Also, stainless steel could be used to lower the weight of the cylinders. With these changes, the system weight including water and desiccant, is 23.8 lb. DTIC

N93-28464# Little (Arthur D.), Inc., Cambridge, MA.
HYBRID OXYGEN SYSTEM Final Report, Sep. 1986 - Dec. 1991
W. D. LEE Oct. 1992 197 p
(Contract F33615-86-C-4505)
(AD-A262417; REPT-56913-10; AL-TR-1992-0014) Avail: CASI HC A09/MF A03

Investigation of concepts for generating oxygen on-board combat aircraft and development of a bleed air-driven refrigeration, liquefaction, and cryogenic storage system for oxygen were undertaken in this study. A number of alternative approaches were examined while considering size, weight and power consumption. An open-loop bleed air-driven system was selected for design, development, and testing. The bleed air-driven refrigeration unit achieved oxygen liquefaction temperatures of 90 deg K and liquefied and stored oxygen generated from a molecular sieve oxygen generating system (MSOGS). The oxygen was stored in cryogenic dewars, vaporized, and withdrawn from the system to simulate aircrew consumption. A heat exchanger flow reversing valving system was used to sublime and blow out condensates (water vapor and carbon dioxide) which normally collect in an open-loop refrigeration cycle operating from ambient air. The collection of condensate in the cryogenic system represented the largest technological area to overcome, and the reverse cycle system overcame the problem. The laboratory demonstrator utilized a helium cycle cold head refrigeration unit in conjunction with a J-T valve to simulate a cryogenic expander to be used in the flight system. Further work to incorporate a cryogenic expander in place of the cold head and J-T valve is recommended. DTIC

N93-28479# General Electric Co., Gilbert, AZ. Government Services.
LOW-COST HELMET-MOUNTED DISPLAYS Final Technical Report, Apr. 1991 - Apr. 1992
ROGER W. LEINENWEVER, LEONARD G. BEST, and BRYCE J. ERICKSEN Feb. 1993 14 p
(Contract F33615-88-C-0014)
(AD-A262616; AL-TR-1993-0008) Avail: CASI HC A03/MF A01

This report contains two papers presented at the Helmet-Mounted Displays IV, International Symposium and Exhibition on Optical Engineering and Photonics, held at Orlando, FL on 20-24 April 1992. This symposium was sponsored by the Society of Photo-Optical Instrumentation Engineers (SPIE). The papers describe the development and demonstration of two helmet-mounted displays: a low-cost monochrome helmet display and a low-cost color helmet display, both with see-through optics. The present monochrome CRT display helmet design, through demonstrations and system measurements, provided positive data as a research device. The color LCD helmet display system was successfully completed and although the resolution of the LCD matrix structure is not suited for the application of small text in the presentation, the high contrast and vivid colors produced by the LCD, as well as the see-through function of the optics, provide the capability for a full field-of-regard visual simulation system which can be used in conjunction with low-cost cockpit training devices. DTIC

N93-28757# Chemical Warfare/Chemical and Biological Defense Information Analysis Center, Edgewood, MD.
EVALUATION OF TEST METHODS AND REQUIREMENTS FOR RESPIRATORY PROTECTION SYSTEMS 21 Final Report
T. L. RAMIREZ, K. M. REED, M. R. PERRY, C. M. GROVE, and D. E. MOLNAR Nov. 1992 73 p
(Contract DLA900-86-C-2045)
(AD-A262466; CBIAC-SS-335) Avail: CASI HC A04/MF A01

The Joint Services Operational Requirements (JSOR) for vision, communications, respiration, thermal, personal support, compatibility, and psychological factors are presented in this summary. The body of the report provides the test methods used with other pertinent information. The test equipment and cost of equipment are provided with recommendations for selection of the test and the equipment. The recommendation section provides a synopsis of the findings and suggested equipment the advanced protective systems integration laboratory may want to evaluate for use with advanced mask design. DTIC

N93-28850# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Flight Mechanics Panel.
COMBAT AUTOMATION FOR AIRBORNE WEAPON SYSTEMS: MAN/MACHINE INTERFACE TRENDS AND TECHNOLOGIES [L'AUTOMATISATION DU COMBAT AERIEN: TENDANCES ET TECHNOLOGIES POUR L'INTERFACE HOMME/MACHINE]
Apr. 1993 268 p Symposium held in Edinburgh, Scotland, 19-22 Oct. 1992
(AGARD-CP-520; ISBN-92-835-0706-1) Copyright Avail: CASI HC A12/MF A03

Recent advances in combat automation technologies offer significant potential for improving overall mission effectiveness. Development of advanced situational awareness display concepts, parallel distributed computer architecture, and tactical information fusion techniques have paved the way for new operational capabilities and weapon system employment tactics. Harnessing these innovative technologies is critically dependent upon establishing an effective and intuitive pilot vehicle interface. The symposium addressed changing and possible future operational scenarios, advanced technology concepts, application issues and experimental development efforts and included sessions on: fusion, situation awareness, human capabilities and limitations, and design and evaluation of integrated systems.

N93-28853# Elliott-Automation Space and Advanced Military Systems Ltd., Camberley (England). Aerospace Systems Div.
PILOT DECISION AIDING FOR WEAPON DELIVERY: A NOVEL APPROACH TO FIRE CONTROL CUEING USING PARALLEL COMPUTING
A. R. BUFFETT and R. M. WIMBUSH *In* AGARD, Combat

Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 18 p Apr. 1993
Copyright Avail: CASI HC A03/MF A03

This paper describes the application of advanced technology, both hardware and software, to provide improved pilot Man-Machine Interface (MMI) automation for the central function of an airborne weapon system, namely weapon release. The specific scenario addressed is that of providing the pilot with decision aiding, in the form of firing cues, for the use of air-to-air missiles. The paper gives an overview of the need for automation/decision aiding in air-to-air missile fire control, by illustrating the way in which missile performance can vary greatly with the changes of engagement parameters which occur rapidly in an air-to-air combat scenario. The high pilot workload in this type of scenario, and the future requirement for multiple simultaneous missile firings, further support the need for automation to provide pilots with simple, processed, predictive data on which to base their firing decisions. Derived from text

N93-28855# Universitaet der Bundeswehr Muenchen, Neubiberg (Germany). Inst. fuer Systemdynamik und Flugmechanik.
PILOT INTENT AND ERROR RECOGNITION AS PART OF A KNOWLEDGE BASED COCKPIT ASSISTANT
T. WITTIG and R. ONKEN *In* AGARD, Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 10 p Apr. 1993
Copyright Avail: CASI HC A02/MF A03

A Pilot Intent and Error Recognition module as part of a knowledge based Cockpit Assistant System is presented, which is being developed at the University of the Armed Forces in Munich in cooperation with the Dornier company and implemented in a flight simulator. The system mainly supports the pilot crew with regard to the monitoring and planning task and provides assistance for a number of plan execution functions for the civil flight operation under Instrument Flight Rules. During the whole flight, the Pilot Intent and Error Recognition module monitors pilot activities and the flight status in order to detect deviations from the actual flight plan immediately. In this case, the current flight situation is evaluated, the pilot behavior is analyzed over a certain time period and by use of both pilot intent or error is recognized. Pilot errors lead to warning messages, and recognized pilot intent to a modification of the flight plan. In this paper, a short survey is given of the concept and the function of the Cockpit Assistant System. After that the structure of the Pilot Intent and Error Recognition will be described in detail. At the end, the integration of this module into the Cockpit Assistant System and the evaluation in a flight simulator are presented. Derived from text

N93-28856# Defence Research Agency, Bedford (England). Flight Dynamics and Simulation Div.
THE DESIGN AND DEVELOPMENT OF THE NEW RAF STANDARD HUD FORMAT
J. R. HALL *In* AGARD, Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 11 p Apr. 1993 Sponsored by RAF
Copyright Avail: CASI HC A03/MF A03

In poor weather and on instruments, the safe piloting of an aircraft requires the display of basic flight information to the pilot in a manner that is instinctive, immediate, and unambiguous. Head-up display formats have singularly failed in this regard over the years and are known to be a contributing factor in many incidents involving lack of spatial awareness by the pilot. This paper describes the theory, experimental development, and flight proving of the DRA Fast-Jet HUD Format (FJF). This format has been designed to keep the pilot spatially aware under the most dynamic of flight maneuvers while retaining the flight-path information so necessary for mission effectiveness during normal tactical maneuvering and steady flight conditions. These include low level night operations with FLIR and NVGs and highly dynamic, hard maneuvering flight in poor weather or on instruments either at low level or in the air-to-air role. Derived from text

N93-28857# Dornier Luftfahrt G.m.b.H., Friedrichshafen (Germany). Flight Simulation Dept.
SYMBOLOGY FOR HEAD UP AND HEAD DOWN APPLICATIONS FOR HIGHLY AGILE FIGHTER AIRCRAFT: TO IMPROVE SPATIAL AWARENESS, TRAJECTORY CONTROL, AND UNUSUAL ATTITUDE RECOVERY, PART 1
G. FISCHER and W. FUCHS *In* AGARD, Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 6 p Apr. 1993
Copyright Avail: CASI HC A02/MF A03

The progressively increasing agility of modern fighter aircraft (a/c) with high onset and high sustained pitch and roll rates makes spatial orientation and awareness an even more demanding task for the operator. Pilots already complain about fast moving and twisting pitch bars in the HUD and the necessity to concentrate almost their entire attention on maintaining spatial orientation. Scaled and geared pitch bars relieved the problem to some extent but didn't solve it, at least according to our opinion. The above mentioned problems are aggravated with the introduction of advanced fighter a/c capable of even higher onset and angular rates and flying at higher angles of attack (AoA) or even in the post-stall regime where the actual flight path in space and the a/c attitude may deviate to a great extent. In order to overcome the problems mentioned above, a more stationary and more easily interpretable reference symbology, a circular arc segment, is used to indicate pitch (theta) or flight path angle (gamma), whereas the roll angle (phi) is given by the angular relation between a/c reference symbol and the center of the arc segment.
Author (revised)

N93-28858# Rockwell International Corp., Los Angeles, CA.
VIRTUAL INTERFACE APPLICATIONS FOR AIRBORNE WEAPONS SYSTEMS
EMILY HOWARD *In* AGARD, Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 6 p Apr. 1993
Copyright Avail: CASI HC A02/MF A03

This paper addresses a class of control and display technology that shall be referred to collectively as Virtual Interface (VI) technology. The contents of this paper are presented in three parts. Part 1 will describe what is meant by a 'virtual interface,' a suite of control and display technology being developed for future implementation in operational aircraft systems. The problem that will be discussed is how the transition process between development and operational status is particularly difficult for VI technology, given current applications. Part 2 will describe some new applications of VI technology, based upon several programs that utilize embedded simulation for operational test and evaluation and training purposes. A review of the benefits of VI technology shows promise for accelerating the transition process at least toward these operational activities. Part 3 then will describe a new display concept, based on virtual interface technology, that was designed for one of these embedded simulation applications and conclude with a discussion of plans for future development.
Author (revised)

N93-28859# General Dynamics Corp., Fort Worth, TX.
HEAD-STEERED SENSOR FLIGHT TEST RESULTS AND IMPLICATIONS
L. N. LYDICK *In* AGARD, Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 7 p Apr. 1993
Copyright Avail: CASI HC A02/MF A03

A comprehensive flight test program of a head-steered FLIR/HMD night attack system was conducted between Aug. 1987 and Jan. 1990. Seventy-five development and demonstration F-16B flights were flown. Approximately 90 percent of the flights were conducted in night visual meteorological conditions. The remainder were conducted in daytime with the pilot's vision obscured by an opaque visor cover to simulate night and to study laser eye protection. Because the new FLIR/HMD systems were fully integrated with the F-16B fire control, navigation, communication, and display system, it was possible to achieve a considerable

degree of tactical relevance in the tests. The night attack portion of the testing was a subset of a broader series of tests to explore advanced techniques for close air support (CAS). The work was industry sponsored by a number of corporations in a cooperative effort of about thirty million dollars. The tests and demonstrations culminated in operational test by (then) Tactical Air Command pilots at Nellis Air Force Base, Nevada, and Fort Hood, Texas. The night CAS systems evaluations were quite favorable and were planned for production until the remarkable end of the cold war reoriented (or perhaps gave pause to) planned introduction of the concepts to the fleet. In this paper, the author provides a summary overview of the mission, a description of the systems, the lessons learned, and some thoughts about future system requirements.
Author (revised)

N93-28860# Defence Research Agency, Farnborough (England). Flight Systems Dept.
THE QUEST FOR AN INTEGRATED FLYING HELMET
A. KARAVIS and D. N. JARRETT *In* AGARD, Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 19 p Apr. 1993
Copyright Avail: CASI HC A03/MF A03

The addition of vision enhancement, display, and control functions to aviator's headgear is operationally attractive. The jets and helicopters that are currently under development call for headgear with a combination of these novel facilities. This paper reviews the recent history of such helmet systems, which demonstrate admirably the inventiveness of the design teams. However, there are attendant perceptual and operational concerns and the addition of extra components invariably compromises basic ergonomic qualities. A new design philosophy, which emphasizes functional integration rather than the incorporation of compatible sub-systems, is emerging. This will be assisted significantly when key optical and electro-optical technologies become mature.
Author (revised)

N93-28861# Royal Air Force Inst. of Aviation Medicine, Farnborough (England). Biodynamics Div.
THE PHYSIOLOGICAL LIMITATIONS OF MAN IN THE HIGH G ENVIRONMENT
N. D. C. GREEN *In* AGARD, Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 8 p Apr. 1993
Copyright Avail: CASI HC A02/MF A03

The physiological limitations imposed upon man by the high-G environment are discussed, with particular reference to the cardiovascular, respiratory, and musculo-skeletal systems. Anti-G technology has been developed specifically for agile fighter aircraft, but it is apparent that if man is to have the capacity to tolerate any further increases in aircraft agility, a radically different approach to G protection is required. The most effective physiological solution is to change the orientation of the pilot such that his long axis is no longer in the plane of greatest acceleration, entailing major cockpit redesign. This and other solutions are examined, and their acceptability to aviators is considered. Author (revised)

N93-28862# British Aerospace Public Ltd. Co., Bristol (England). Research Centre.
OCULO-MOTOR RESPONSES AND VIRTUAL IMAGE DISPLAYS
G. K. EDGAR, C. NEARY, I. CRAIG, and J. C. D. POPE *In* AGARD, Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 8 p Apr. 1993
Copyright Avail: CASI HC A02/MF A03

Virtual image displays are likely to become more prominent in the cockpit, the most common examples being the head-up display (HUD) and, more recently, the helmet-mounted display (HMD). This paper describes a series of experiments highlighting some of the advantages and disadvantages of displays of this type. The first experiments demonstrate that introducing perceived depth differences into displays may improve eye-tracking performance. The second series of experiments illustrates some of the problems with virtual image displays; namely that the eyes may be inappropriately accommodated (focused) when using virtual image displays. The possible consequences of these problems are discussed. Author

N93-28863# Texas Technological Univ., Lubbock. Dept. of Industrial Engineering.
HUMAN CAPABILITIES AND LIMITATIONS IN SITUATION AWARENESS
MICA R. ENDSLEY and CHERYL A. BOLSTAD (Monterey Technologies, Inc., Cary, NC.) *In* AGARD, Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 10 p Apr. 1993
Copyright Avail: CASI HC A02/MF A03

Achieving high situation awareness (SA) is a major goal in the design of aircraft systems. Efforts are currently underway by a number of individuals who are attempting to address this need through improvements in avionics system design, automation, and the pilot-vehicle interface (PVI). These efforts can be greatly enhanced through an understanding of human capabilities and limitations in achieving SA. This paper presents an identification of those factors which underlie basic human SA capabilities, including key information processing mechanisms, critical human skills, and a discussion of external factors which act to hamper SA. The implications of each of these issues for the design of systems, including PVI and automation efforts, are discussed.
Author

N93-28864# Royal Air Force Inst. of Aviation Medicine, Farnborough (England).
OPERATOR AND AUTOMATION CAPABILITY ANALYSIS: PICKING THE RIGHT TEAM
R. M. TAYLOR and S. J. SELCON *In* AGARD, Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 17 p Apr. 1993
Copyright Avail: CASI HC A03/MF A03

A review of the role of operator and automation capability analysis in aircrew systems design is provided. The changing perceptions of human and machine functionality with increasing machine capability, from early pilot-in-the-loop control, through to the division and sharing of responsibilities for systems management and mission problem solving, are charted. Concepts for the integration of human and machine resources in the performance of physical and cognitive tasks, including decision-making, are discussed in the context of developments in machine intelligence. Operator capability and task analysis, and the modeling of human performance, are seen to have developed from providing tools for system design, to giving critical support for real-time dynamic function allocation in advanced adaptive systems. A model of cooperative teamwork, with the machine conceived of as an electronic-crew teaming resource, is proposed as broad framework for thinking about future adaptive systems requirements. The results of a recent study of human-electronic crew teamwork with RAF Harrier and Tornado aircrew are reported. The results provide evidence for the validity of the teamwork model, and indicate directions for extending the capability for cooperative functioning in future aircrew adaptive systems. Author (revised)

N93-28865# Aerospace Medical Research Labs., Wright-Patterson AFB, OH. Human Engineering Div.
COGNITIVE INTERFACE CONSIDERATIONS FOR INTELLIGENT COCKPITS
ROBERT G. EGGLESTON *In* AGARD, Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 16 p Apr. 1993
Copyright Avail: CASI HC A03/MF A03

The concept of an Intelligent Cockpit as a knowledge-based aiding system is presented. It argues that, in order to maximally support the air crew, user aiding in two areas is required: mission task aiding and interface useability aiding. These areas of aiding are discussed in relation to four different forms of an intelligent cockpit. The central purpose, however, is to introduce the concept of a cognitive design requirement for aiding systems, and to suggest

its importance to design solutions expected to achieve crew aiding in both the mission task and interface useability areas. Two arguments are made: (1) A deeper knowledge of human capabilities and limitations is needed to generate effective cognitive design requirements for an aiding system; and (2) more cognitive design requirements are needed for an intelligent cockpit in comparison with a conventional one. Illustrations of possible cognitive design requirements are presented in support of these arguments. Special attention is given to requirements that derive from human capabilities and limitations. Based on the general discussion, it is also concluded that an intelligent cockpit should be a separate module from the traditional systems avionics, since it requires a unique process architecture. Author (revised)

N93-28866# British Aerospace Public Ltd. Co., Kingston-upon-Thames (England). Military Aircraft Div.
ERGONOMIC DEVELOPMENT OF DIGITAL MAP DISPLAYS
ADRIAN MARTEL and GEORGE A. WARD *In* AGARD, Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 8 p Apr. 1993
Copyright Avail: CASI HC A02/MF A03

In the high workload environment of the cockpit, the importance of efficient transfer of information from visual displays to the pilot is of the highest priority. British Aerospace, Kingston, has developed a prototype Situational Awareness display which successfully combines tactical information with a digital map and aeronautical information. The interface in terms of presentation and functionality is designed to complement the process whereby visual information is cognitively integrated into mental models of Situational Awareness by the user. The development of the display involved a comprehensive literature search on perception and cognition, analysis of map representations, and an iterative evaluation whereby successive prototypes were developed and refined. The many visual design principles which were identified during this work which were successfully incorporated into this display and which may in addition be of great benefit to other displays are detailed. Where displays are being radically revised, a holistic redesign from first principles is preferable to simply adding new features. Author (revised)

N93-28867# Wright Lab., Wright-Patterson AFB, OH.
SYSTEM AUTOMATION AND PILOT-VEHICLE-INTERFACE FOR UNCONSTRAINED LOW-ALTITUDE NIGHT ATTACK
T. O. CHURCH and W. S. BENNETT, II (General Dynamics Corp., Fort Worth, TX.) *In* AGARD, Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 7 p Apr. 1993
Copyright Avail: CASI HC A02/MF A03

Unconstrained low-altitude night attack is achievable today through automation and integration of current technologies. Many of these technologies are advanced avionic systems that still require additional development before they are production-ready. However, their performance and synergistic benefits have been demonstrated. Additional efforts are still warranted to increase system safety, improve situational awareness, decrease pilot workload, and provide a more effective weapon system. Author

N93-28870# Rockwell International Corp., Los Angeles, CA.
REQUIREMENTS FOR PILOT ASSISTANCE IN A THRUST-VECTORING COMBAT AIRCRAFT
EMILY HOWARD and ROBERT E. BITTEN *In* AGARD, Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 15 p Apr. 1993
(Contract N00019-88-C-0288)
Copyright Avail: CASI HC A03/MF A03

With the emergence of thrust-vectoring aircraft such as the X-31 and F-22, new questions arise regarding the maximum potential of this technology for increasing air-to-air combat effectiveness. Recent dome-to-dome (man-in-the-loop) simulations have demonstrated a significant increase in close-in air combat effectiveness with the addition of thrust vector capability. Much of this increased effectiveness can be attributed to the ability of the thrust-vectoring aircraft to continue maneuvering while operating well beyond conventional aircraft stall limits. Such poststall maneuvering (PST) can dramatically increase an aircraft's turn rate while simultaneously minimizing its turn radius, providing a significant tactical advantage in close in air combat. Comparisons with all-digital (computer-in- the-loop) simulations under the same test conditions, however, show that the combat effectiveness of PST is consistently greater within the all-digital analyses than within the all-manned analyses. These comparisons are summarized and whether pilots may require supplemental assistance in order to exploit the full potential of PST utility is considered. Through analysis of both man- and computer-in-the-loop combat simulations, requirements for pilot assistance were tentatively identified, along with some of the methods applicable to meeting these requirements. These methods include expanded training, improved displays, and increased automation. The results of this analysis, based upon the studies available to date, are presented. Plans for further analysis and validation studies are described.
Author (revised)

N93-28872# National Aerospace Lab., Amsterdam (Netherlands).
OVERVIEW OF COCKPIT TECHNOLOGY RESEARCH AND DEVELOPMENT PROGRAMS FOR IMPROVEMENT OF THE MAN/MACHINE INTERFACE: REVIEW OF THE AGARD AVP SYMPOSIUM HELD IN MADRID, MAY 1992
P. J. M. URLINGS and E. W. PIJPERS *In* AGARD, Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies 12 p Apr. 1993
Copyright Avail: CASI HC A03/MF A03

A review of the AGARD Avionics Panel (AVP) symposium on 'Advanced Aircraft Interfaces: The Machine Side of the Man-Machine Interface', held in May 1992 at Madrid is provided. The theme of this symposium was limited to the 'machine-side' since a subsequent AGARD symposium at Edinburgh, Scotland, later that year was scheduled to cover the 'man-side' of the subject. The main findings of the Madrid symposium were summarized for presentation in Edinburgh. The complete text of the papers of the AVP symposium can be found in AGARD Conference Proceedings CP-521. Author (revised)

N93-28884# Army Research Inst. of Environmental Medicine, Natick, MA.
BIOPHYSICAL MODEL FOR HANDWEAR INSULATION TESTING
W. R. SANTEE, L. A. BLANCHARD, S. K. CHANG, and R. R. GONZALEZ Mar. 1993 26 p
(AD-A262926; USARIEMT7-93) Avail: CASI HC A03/MF A01

Biophysical models of hands, feet, and full manikins are used for direct measurement of clothing insulation. Thermal resistance values (m(sup 2)K/W) were measured with a weather resistant and simplified 7 zone hand model with upgraded controls and then compared to values from a 22 zone articulated copper model. Insulation is calculated from the power demand required to maintain a selected surface temperature setpoint at known thermal gradient between the surface setpoint and the environment. For the new model, dry insulation values were 0.21 m(sup 2)K/W for the standard military trigger finger mitten and 0.12 m(sup 2)K/W for the light-duty shell. Values for the 22 section copper hand model were 0.23 and 0.14 m(sup 2)K/W, respectively. Both hand models provide replicable measurements of relative total handwear insulation. DTIC

N93-28897# Oxford Univ. (England). Robotics Research Group.
A MODULAR HEAD/EYE PLATFORM FOR REAL-TIME REACTIVE VISION
IAN D. REID, PAUL M. SHARKEY, PHILIP F. MCLAUCHLAN, and DAVID W. MURRAY 1992 12 p
(OUEL-1941/92; ETN-93-93877) Avail: CASI HC A03/MF A01

The design and implementation of a high speed reactive system in which the primary sense is vision are presented. An architecture for visual processing based around a configurable network of general purpose processors is described. A purpose built, versatile,

high quality engineered mount based on geared DC motors was developed to facilitate rapid redirection of gaze. Performance results for this device are presented. Results for a preliminary implementation of closed loop visual control using a brightest spot detector are given. ESA

N93-28941# Army Research Lab., Aberdeen Proving Ground, MD.
A STUDY OF THE EFFECTS OF LENS FOCAL LENGTH ON REMOTE DRIVER PERFORMANCE Final Report
MONICA M. GLUMM, PATRICIA W. KILDUFF, and AMY S. MASLEY Nov. 1992 35 p
(Contract DA PROJ. 1L1-62716-AH-70)
(AD-A263191; ARL-TR-25) Avail: CASI HC A03/MF A01

The effects of three lens focal lengths on remote driving performance were measured. The three focal lengths and their corresponding horizontal fields of view (FOV's) were 12 mm (29 deg), 6 mm (55 deg), and 3.5 mm (94 deg). On-board driving performance (direct view) was also measured. The study was conducted on an indoor test course consisting of six segments: straightaways, right-hand turns, left-hand turns, serpentine, figure 8, and obstacle avoidance. The findings are presented. DTIC

N93-28942# Edgerton, Germeshausen and Grier, Inc., Idaho Falls, ID.
CRUCIAL ROLE OF DETAILED FUNCTION, TASK, TIMELINE, LINK, AND HUMAN VULNERABILITY ANALYSES IN HRA
T. G. RYAN, L. N. HANEY, and L. T. OSTROM 1992 20 p Presented at the Reliability and Maintainability Symposium, Atlanta, GA, 26-28 Jun. 1993
(Contract DE-AC07-76ID-01570)
(DE93-001923; EGG-M-92402; CONF-930661-1) Avail: CASI HC A03/MF A01

This paper addresses one major cause for large uncertainties in human reliability analysis (HRA) results, that is, an absence of detailed function, task, timeline, link, and human vulnerability analyses. All too often this crucial step in the HRA process is done in a cursory fashion using word of mouth or written procedures which themselves may incompletely or inaccurately represent the human action sequences and human error vulnerabilities being analyzed. The paper examines the potential contributions these detailed analyses can make in achieving quantitative and qualitative HRA results which are as follows: (1) creditable, that is, minimize uncertainty; (2) auditable, that is, systematically linking quantitative results and qualitative information from which the results are derived; (3) capable of supporting root cause analyses on human reliability factors determined to be major contributors to risk; and (4) capable of repeated measures and being combined with similar results from other analyses to examine HRA issues transcending individual systems and facilities. Based on experience analyzing test and commercial nuclear reactors, and medical applications of nuclear technology, an iterative process is suggested for doing detailed function, task, timeline, link and human vulnerability analyses using documentation reviews, open-ended and structured interviews, direct observations, and group techniques. Finally, the paper concludes that detailed analyses done in this manner by knowledgeable human factors practitioners, can contribute significantly to the credibility, auditability, causal factor analysis, and combining goals of the HRA. DOE

N93-28977*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, AL.
COMPUTERIZED ATMOSPHERIC TRACE CONTAMINANT CONTROL SIMULATION FOR MANNED SPACECRAFT
J. L. PERRY Jun. 1993 171 p Sponsored by NASA, Washington
(NASA-TM-108409; NAS 1.15:108409) Avail: CASI HC A08/MF A02

Buildup of atmospheric trace contaminants in enclosed volumes such as a spacecraft may lead to potentially serious health problems for the crew members. For this reason, active control methods must be implemented to minimize the concentration of atmospheric contaminants to levels that are considered safe for prolonged, continuous exposure. Designing hardware to accomplish this has traditionally required extensive testing to characterize and select appropriate control technologies. Data collected since the Apollo project can now be used in a computerized performance simulation to predict the performance and life of contamination control hardware to allow for initial technology screening, performance prediction, and operations and contingency studies to determine the most suitable hardware approach before specific design and testing activities begin. The program, written in FORTRAN 77, provides contaminant removal rate, total mass removed, and per pass efficiency for each control device for discrete time intervals. In addition, projected cabin concentration is provided. Input and output data are manipulated using commercial spreadsheet and data graphing software. These results can then be used in analyzing hardware design parameters such as sizing and flow rate, overall process performance and program economics. Test performance may also be predicted to aid test design. Author

N93-29044*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
ANTHROPOMETRIC DATA FROM LAUNCH AND ENTRY SUITED TEST SUBJECTS FOR THE DESIGN OF A RECUMBENT SEATING SYSTEM
LARA E. STOYCOS (Lockheed Engineering and Sciences Co., Houston, TX.) and GLEN K. KLUTE Jun. 1993 29 p
(Contract NAS9-17900)
(NASA-TM-104769; S-720; NAS 1.15:104769) Avail: CASI HC A03/MF A01

Returning space crews to Earth in a recumbent position requires the design of a new seating system. Current anthropometric data are based on measurements taken while the subjects were unsuited and sitting. To be most accurate, it is necessary to design by measurements of subjects in the launch and entry suit in a recumbent position. Since the design of the recumbent seating system must meet the requirements of both 5th percentile Japanese female and 95th percentile American male crew members, a delta is reported rather than absolute measurements of the test subjects. This delta is the difference in the measurements taken with the subjects unsuited and sitting and those taken with the subjects suited and recumbent. This delta, representative of the change due to the suit, can be added to the existing Man-Systems Integration Standards (NASA-STD-3000) anthropometric data to project the measurements for 5th percentile Japanese female and 95th percentile American male crew members. A delta accounting for the spinal elongation caused by prolonged exposures to microgravity is added as well. Both unpressurized and pressurized suit conditions are considered. Background information, the test protocol and procedure, analysis of the data, and recommendations are reported. Author (revised)

N93-29324*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
ANTHROPOMETRIC SURVEY OF THE ASTRONAUT APPLICANTS AND ASTRONAUTS FROM 1985 TO 1991
SUDHAKAR L. RAJULU (Lockheed Engineering and Sciences Co., Houston, TX.) and GLENN K. KLUTE May 1993 96 p
(Contract NAS9-17900)
(NASA-RP-1304; S-718; NAS 1.61:1304) Avail: CASI HC A05/MF A01

The Anthropometry and Biomechanics Laboratory at the Johnson Space Center has been collecting anthropometric data from astronaut applicants since 1977. These anthropometric measurements had been taken from 473 applicants. Based on the position they applied for, these applicants were classified as either mission specialists, payload specialists, pilots, or observers. The main objective was to document the variations among these applicants and tabulate the percentile data for each anthropometric dimension. The percentile and the descriptive statistics data were tabulated and graphed for the whole astronaut candidate population; for the male and female groups; for each subject classification such as pilot, mission specialist, and payload

specialist; and finally, for those who were selected as astronauts.
Author (revised)

N93-29340# Mitre Corp., Bedford, MA.
HEAD MOUNTED DISPLAYS FOR VIRTUAL REALITY
PAUL J. HEZEL and HARRY VERON Feb. 1993 49 p
(Contract F19628-89-C-0001)
(AD-A263498; MTR-93B0000015) Avail: CASI HC A03/MF A01

One of the goals in the development of Virtual Reality (VR) is to achieve total immersion where one sees and interacts with objects in a virtual world in the same way that one sees and interacts with the objects of the real world. One becomes immersed in another world through the sense of sight. Thus the technique of displaying a virtual environment determines, in part, the degree to which one can become transported out of the real world and into the virtual world. The developers of VR have utilized the head mounted display (HMD) as a means of displaying the virtual environment to the user. The HMD is not new but has seen widespread use as an information display in military aircraft. In an HMD, displays and imaging optics mounted on a headset provide a virtual image in front of the eyes. In the VR domain, this design provides the user with a view of the virtual environment while blocking out the user's real environment. A tracking device allows the computer to present a viewpoint corresponding to the user's head position and orientation, thus enabling freedom of movement for the user within the virtual environment. These and other characteristics enhance the total immersion capabilities of the HMB. DTIC

55

SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

N93-28895*# Harvard Univ., Cambridge, MA.
WIDE-BANDWIDTH HIGH-RESOLUTION SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE Semiannual Status Report, 15 Dec. 1992 - 15 Jun. 1993
PAUL HOROWITZ 15 Jun. 1993 26 p
(Contract NAGW-2872)
(NASA-CR-193137; NAS 1.26:193137) Avail: CASI HC A03/MF A01

Research accomplished during the third 6-month period is summarized. Research covered the following: dual-horn antenna performance; high electron mobility transistors (HEMT) low-noise amplifiers; downconverters; fast Fourier transform (FFT) array; and backend 'feature recognizer' array. CASI

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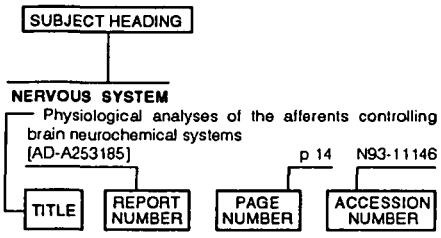

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A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

R

S

T

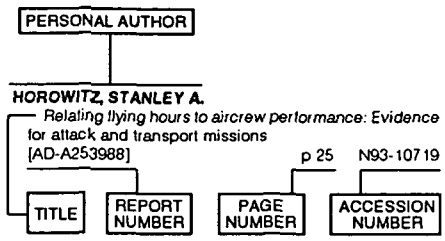
U

V

W

Y

Typical Personal Author Index Listing



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C

D

E

F

G

H

I

J

K

L

M

N

O

P

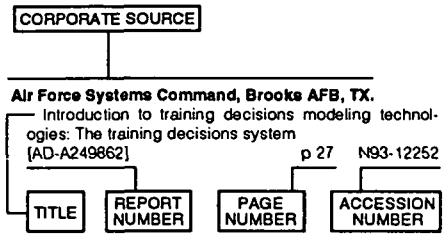
R

S

T

CORPORATE SOURCE INDEX

Typical Corporate Source Index Listing



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A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

R

S

T

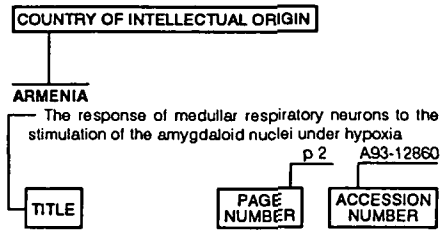
U

V

W

FOREIGN TECHNOLOGY INDEX

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 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.

C

CANADA
Effects of long-term weightlessness on roll circularvection p 279 A93-39725
Effects of sleep deprivation and exercise on glucose tolerance p 281 A93-41165
Influence of the Cold Buster (tm) sports bar on heat debt, mobilization and oxidation of energy substrates [AD-A262762] p 285 N93-28939

CHINA
Hypoxic ventilatory responsiveness in Tibetan compared with Han residents of 3,658 m p 280 A93-41120

D

DENMARK
Influence of in vivo hypobaric hypoxia on function of lymphocytes, neutrocytes, natural killer cells, and cytokines p 280 A93-41123

F

FINLAND
The prediction of the adaptation of circadian rhythms to rapid time zone changes p 278 A93-39714

FRANCE
Microgravity and orthostatic intolerance - Carotid hemodynamics and peripheral responses p 278 A93-39716
Dynamic analysis of human visuo-oculo-manual coordination control in target tracking tasks p 287 A93-41166
Norepinephrine content in discrete brain areas and neurohypophysial vasopressin in rats after a 9-d spaceflight (SLS-1) p 273 A93-41167
Development of the Hermes EVA Space Suit Glove [SAE PAPER 921256] p 299 A93-41426
Development of a 500 hPa shoulder joint for the European EVA Space Suit System [SAE PAPER 921257] p 299 A93-41427
Design and preliminary testing of a membrane based water recycling system for European manned space missions [SAE PAPER 921396] p 309 A93-41553
Combat Automation for Airborne Weapon Systems: Man/Machine Interface Trends and Technologies [AGARD-CP-520] p 317 N93-28850

G

GERMANY
Ferrous iron oxidation by anoxygenic phototrophic bacteria p 271 A93-39280
Recent regenerative ECLSS technology developments in Europe [SAE PAPER 921332] p 304 A93-41493
Hermes ECLSS - Main requirements and technical solutions [SAE PAPER 921400] p 309 A93-41555
DOKMA: A document oriented communication model for medical applications as a basis of a role system in the medical field [ETN-93-93799] p 284 N93-28469
Pilot intent and error recognition as part of a knowledge based cockpit assistant p 318 N93-28855
Symbology for head up and head down applications for highly agile fighter aircraft: To improve spatial awareness, trajectory control, and unusual attitude recovery, part 1 p 318 N93-28857
Photobiological investigations on spores of streptomyces griseus [ESA-TT-1269] p 277 N93-29274

I

INDIA
Mathematical model for the exchange of gases in the lungs with special reference to carbon monoxide p 271 A93-39707
Body fluid compartments, renal blood flow, and hormones at 6,000 m in normal subjects p 281 A93-41125

INTERNATIONAL ORGANIZATION
European involvement in CELSS - Definition of a Closed Ecological Systems Test Bed [SAE PAPER 921200] p 295 A93-41376

ISRAEL
Performance under dichoptic versus binocular viewing conditions - Effects of attention and task requirements p 287 A93-40772
New technologies for in-flight pasteless bioelectrodes p 289 A93-41174
Visual field information in nap-of-the-Earth flight by teleoperated helmet-mounted displays p 311 N93-27177

ITALY
Long-lasting neuropsychological changes after a single high altitude climb p 278 A93-39713
Myosin and troponin changes in rat soleus muscle after hindlimb suspension p 273 A93-41124
Labels and visual cues to reproduce an earthlike environment in space - Going ahead in designing Columbus APM interior architecture [SAE PAPER 921193] p 295 A93-41371
The effects of a reduced pressure scenario on the Columbus APM environmental control system [SAE PAPER 921247] p 298 A93-41418
System integration and verification approach for the environmental control system of the Columbus Attached Pressurised Module [SAE PAPER 921261] p 299 A93-41431
Environmental control of the Mini Pressurized Logistic Module [SAE PAPER 921281] p 302 A93-41449
Effects of air bubble contamination in recirculating water loop [SAE PAPER 921282] p 302 A93-41450

J

JAPAN
High-altitude pulmonary edema with pulmonary thromboembolism p 278 A93-39709
Neuropharmacology of motion sickness and emesis - A review p 271 A93-39711
Motion sickness induced by sinusoidal linear acceleration in rats p 272 A93-39712
A trade study method for determining the design parameter of CELSS subsystems [SAE PAPER 921198] p 295 A93-41374
Development of the nitrogen fixation system for CELSS [SAE PAPER 921238] p 297 A93-41411
Concept of waste transferring mechanisms [SAE PAPER 921239] p 297 A93-41412
Experimental and theoretical study on membrane distillation using thermopervaporation [SAE PAPER 921397] p 309 A93-41554
Conceptual study on manned lunar surface site p 316 N93-28029
Conceptual study of manned lunar surface site p 316 N93-28031
Manned lunar surface site: Conceptual study on pressurized lunar surface operation rover p 316 N93-28032
Manned lunar surface site p 316 N93-28033
Lunar surface experiment system p 316 N93-28034

N

NETHERLANDS
Barotrauma in Boeing 737 cabin crew p 278 A93-39706
Inhibition of EGF-induced signal transduction by microgravity is independent of EGF receptor redistribution in the plasma membrane of human A431 cells p 272 A93-39715
Overview of cockpit technology research and development programs for improvement of the man/machine interface: Review of the AGARD AVP Symposium held in Madrid, May 1992 p 320 N93-28872

NORWAY
The psychological effects of isolation on a space station - A simulation study [SAE PAPER 921191] p 287 A93-41369

R

RUSSIA
Oxygen regime in the frontal cerebral cortex of monkeys during a two-week space flight p 272 A93-40773
New technology for the analysis of the results of an ultrasound experiment performed in aviation-medicine medical examination p 279 A93-40774
Functions simulation model of integrated regenerable life support system [SAE PAPER 921201] p 295 A93-41377
JPRS report: Science and technology. Central Eurasia: Life sciences [JPRS-ULS-93-005] p 276 N93-28683
JPRS report: Science and technology. Central Eurasia: Life sciences [JPRS-ULS-92-027] p 276 N93-28684

S

SAUDI ARABIA
Case report - Chronic sub-dural hematoma following high-speed ejection p 282 A93-41171

SWEDEN
Intracellular targeting of the Yersinia YopE cytotoxin in mammalian cells induces actin microfilament disruption [FOA-B-40420-4.4] p 275 N93-27989
Plasmid encoded virulence of Yersinia [FOA-B-40419-4.4] p 275 N93-28199

FOREIGN

U

CONTRACT NUMBER INDEX

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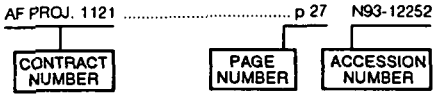

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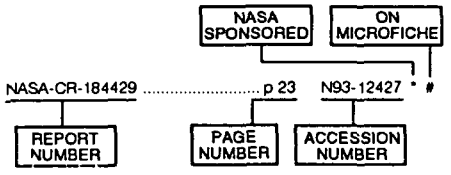

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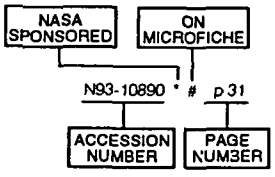

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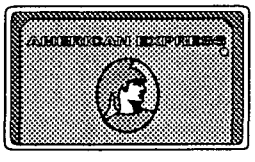

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